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Economic Impact Analysis, RCRA (Resource Conservation and Recovery Act) Interim Status Standards. Volume II

Arthur D. Little, Inc.
Cambridge, MA

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ECONOMIC IMPACT ANALYSIS

RCRA INTERIM STATUS STANDARDS

Volume - II

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APPENDIX A

SPECIFIC COMPLIANCE REQUIREMENTS UNDER RCRA

APPENDIX A

SPECIFIC COMPLIANCE REQUIREMENTS UNDER RCRA

1. IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

The regulation for implementing RCRA Section 3001 appears in Part 261. This Part is the centerpiece of the hazardous waste management system. It identifies and lists those solid wastes that must be managed as hazardous wastes according to the regulations established under Sections 3002 through 3005 and 3010 of RCRA. More precisely, this Part establishes the basic definition of hazardous waste — a solid waste, including waste mixtures; discarded, abandoned, and re-used (recycled or reclaimed) waste that either possesses one of four physical or chemical characteristics, i.e., ignitability, corrosivity, reactivity, or Extraction Procedure (EP) toxicity, or is listed as hazardous in the regulations. This Part also establishes the legal criteria used in identifying and applying these characteristics and in determining if a substance is hazardous for the purpose of inclusion as a listed waste. Finally, this Part specifies the procedures for demonstrating that a listed waste is not hazardous.

Some wastes are exempted or excluded from the regulatory management program — either as not being a solid waste, e.g., domestic sewage or mixtures of domestic sewage treated in a public treatment plant, septic tank pumpings, irrigation return flows, or certain by-products, discharges, or emissions regulated under other Acts; or as a solid waste not to be regulated as a hazardous waste, e.g., household waste, certain on-site mining wastes or "overburden," or drilling fluids associated with oil, gas, or geothermal energy.

The regulations also exclude certain wastes based on the status of the waste generator as a small-quantity generator. Subject to prescribed exceptions for particular kinds of hazardous waste, persons generating and disposing of less than 1000 kilograms (kg) of hazardous waste in any calendar month are also exempted from the regulations, along with those generators who beneficially use, re-use, recycle, or reclaim hazardous waste. The preamble to the regulation states that the 1000-kg exclusion will be reduced to 100 kg, perhaps in steps, sometime between two and five years after the effective date of the regulations.

The regulations in Part 261 are directed to all persons affected by the waste management scheme. They establish a definition of waste hazard, describe the testing and identification methods, and list wastes designated as hazardous. Part 261 regulations are primarily oriented toward definitions and do not directly impose specific compliance requirements and obligations. Instead, they provide an explanation of the requirements set forth in the other Parts.

For example, Part 261 specifies when it must be determined whether a solid waste is hazardous. But, the obligation for generators to make the initial determination of the hazardous characteristics of their wastes is covered in the Section 3002 regulations in Part 262, discussed below.

2. WASTE GENERATOR COMPLIANCE ACTIVITIES

a. General Requirements

The compliance requirements for generators of hazardous waste implement RCRA Section 3002 and are established in Part 262. A waste generator who treats, stores, or disposes of hazardous waste on site must comply with the Part 262 requirements for determining if the waste is hazardous, for obtaining an EPA identification number, and for recordkeeping. Furthermore, this generator must also comply with the requirements of Part 265 (Interim Status Standards) and Part 122 (Permit Applications).

Any person who imports hazardous waste from outside the United States must comply with the requirements for generators.

b. Specific Requirements

Figure A-1 depicts the compliance activity flow required by the Part 262 regulations. The numbered nodes in the figure refer to the numbered paragraphs below.

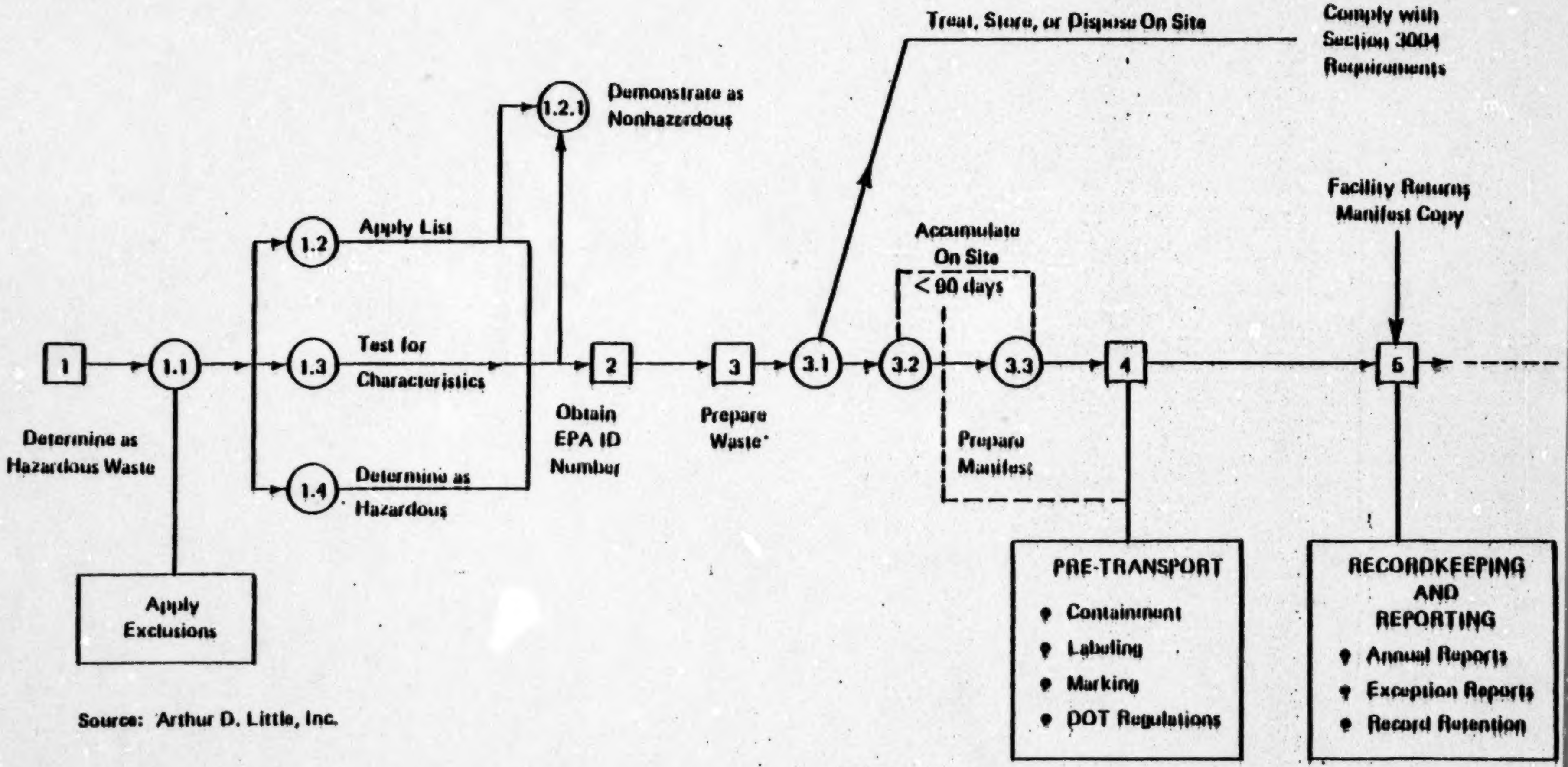
1. Hazardous Waste Determination

All generators must determine whether their waste is hazardous by applying the following steps.

1.1 A waste generator must decide if his wastes are excluded from the regulations under the Part 261 exclusions. For example, farmers generating waste pesticides from their own use are exempted from the Part 262 and other requirements, provided they dispose of the waste on their farms and treat the containers with care (triple rinsing) appropriate to the particular pesticide.

1.2 If a waste is listed as hazardous or examination of the process results in a positive finding, the generator must presume the waste to be hazardous or demonstrate that the particular waste, unlike others in the same category, is not hazardous because it does not meet the criteria against which the waste was listed.

1.2.1 The generator must demonstrate to the EPA Administrator that a listed waste is not hazardous. This demonstration is required for each hazard criterion for which the waste is listed. The Part 260 regulations prescribe the kind of demonstration that a generator must make and identify appropriate options. A submitted demonstration is effective only on approval or failure of EPA to act within 90 days.


1
Determine as Hazardous Waste
1.1
Apply Exclusions
1.2
Apply List
1.3
Test for Characteristics
1.4
Determine as Hazardous
1.2.1
Demonstrate as Nonhazardous
2
Obtain EPA ID Number
3
Prepare Waste*
3.1
Treat, Store, or Dispose On Site
Comply with Section 3004 Requirements
3.2
Accumulate On Site
< 90 days
3.3
Prepare Manifest
4
PRE-TRANSPORT
Containment
Labeling
Marking
DOT Regulations
5
Facility Returns Manifest Copy
RECORDKEEPING AND REPORTING
Annual Reports
Exception Reports
Record Retention

Source: Arthur D. Little, Inc.

FIGURE A–1 GENERATOR COMPLIANCE ACTIVITIES

1.3 If the waste is not listed, generators may evaluate it in accordance with the prescribed characteristics. The Part 261 regulations prescribe the standards by which each characteristic is to be tested.

1.4 A generator may declare an unlisted waste hazardous based on knowledge of the substances or processes used.

2. EPA Identification Numbers

Each generator of hazardous waste must obtain an identification number from EPA through a notification procedure. The identification number is required to treat, store, dispose of, transport, or offer for transport hazardous waste. Furthermore, generators who do not have identification numbers may not offer wastes to transporters or facilities.

3. Preparation for Treatment, Storage, or Disposal

Once it is established that a waste is hazardous and subject to the regulatory program, the requirements for the generator vary, depending on whether the waste is to be processed on or off the site of generation. (Hazardous waste may be shipped only to an off-site facility that is permitted in compliance with the requirements of Part 265.)

3.1 Generators who treat, store, or dispose of hazardous waste on site must comply with the Section 3004 regulations (in Part 265) and fulfill the permitting requirements.

3.2 Hazardous waste awaiting shipment off site may be accumulated on site for up to 90 days. The waste must be in containers that meet Department of Transportation (DOT) standards and are properly labeled and marked. The beginning date for accumulation must be clearly marked and visible for inspection on each container. If the generator accumulates waste for longer than 90 days, the generator is also a storer of waste and must comply with Part 265.

3.3 Properly executed manifests must accompany off-site shipments of waste. Each manifest contains the EPA identification numbers assigned to the generator, transporter(s), and the designated facility, together with the description and quantity of waste. An alternate facility may also be designated for emergency delivery. The manifest must be signed by the generator with sufficient copies to ensure a copy for each affected person. The generator retains one copy and gives the rest to the transporter. (Under the Part 265 regulations the designated facility must acknowledge receipt by returning a copy of the manifest to the generator.)

4. **Pre-Transport Requirements**

Any shipped waste must be transported in accordance with DOT regulations, which specify the packaging, labeling, placarding, and marking requirements. The manifest must include a certification by the generator that the shipment meets DOT and EPA regulations.

5. **Recordkeeping and Reporting**

5.1 Annual Reports summarizing each generator's off-site waste shipments must be submitted on prescribed EPA forms. The generator must keep a copy of the Annual Report for three years. A generator who treats, stores, or disposes on site is required to submit comparable information under the requirements of the Section 3004 regulations.

5.2 Generators are also required to submit Exception Reports on shipments if they have not received a copy of the manifest from the disposal facility within 45 days. These reports must be retained for at least three years.

5.3 The copy of the manifest retained at shipment must be kept for three years or until receipt of the signed copy acknowledging receipt of the waste by the designated facility. The latter copy is to be retained for three years.

5.4 Generators must notify EPA four weeks in advance of shipments to foreign countries.

3. TRANSPORTER'S COMPLIANCE OBLIGATIONS

a. General Requirements

The Part 263 regulations implement RCRA Section 3003 for persons transporting hazardous waste within the United States or from abroad. The regulations apply only if a manifest is required by Part 262. Transportation of hazardous waste on the site of either a waste generator or a permitted facility is excluded.

Part 263 reflects interrelated final rules jointly developed by EPA and DOT. In these regulations, EPA incorporates by reference DOT's rules on labeling, marking, packaging, placarding, and other requirements for in-transit handling of hazardous materials. DOT's final rule incorporates EPA's manifest requirement and expands its list of hazardous materials to include hazardous wastes that require a manifest.

Transporters may also be generators of hazardous waste; they may become generators by mixing wastes or hazard classes into a single package, or by importing wastes. If waste is removed from transport for accumulation or storage, the transporter must comply with the Part 265 requirements for storage.

b. Specific Requirements

(1) EPA Identification Number

A transporter must notify EPA that it transports or intends to transport hazardous waste. Upon notification, EPA will issue an identification number. This number must appear on all manifests for shipments of hazardous waste and any incident report for accidental or intentional discharges.

(2) Compliance with the Manifest System and Recordkeeping

- A transporter may accept hazardous waste from a generator only if it is accompanied by a completed, signed manifest. When a transporter delivers waste to another transporter or a designated facility, he must have the manifest signed and dated, keep one copy, and give the remaining copies to the subsequent transporter or facility.

  Special requirements apply to transportation by rail or bulk shipments by water. For waste destined for a foreign country, transporters must indicate on the manifest the date the waste left the country, sign the manifest, keep one copy, and return a signed copy to the generator.

- The transporter must deliver the entire quantity of hazardous waste to the designated facility (or an alternate facility if an emergency prevents delivery to the designated facility), the next transporter, or the place outside the country designated by the generator. If this is not possible, the transporter must contact the generator for further directions and revise the manifest accordingly.

- A transporter must keep copies of signed manifests for three years from the date of initial acceptance. For bulk shipments, the transporter may retain the shipping papers. Retention periods may be extended during enforcement actions.

(3) Hazardous Waste Discharges

- If an accidental or intentional discharge on or into land or water occurs during transportation, the transporter must take immediate action to protect human health and the environment. If immediate removal is necessary, the waste may be carried by transporters who do not have EPA identification numbers. In accordance with DOT regulations, certain discharges must be reported to the National Response Center and DOT's Office of Hazardous Materials Regulation.

- A transporter must clean up any hazardous waste discharge or take action so that there is no threat to human health or the environment.

4. COMPLIANCE ACTIVITIES FOR HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

a. General Requirements

Standards and requirements for hazardous waste management facilities are contained in two sets of regulations implementing Section 3004 of RCRA.

- Part 264, Standards For Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. This Part contains the standards that will be used to issue permits for facilities. The May 19, 1980 promulgation of this Part was confined to general, management-type requirements that are not highly technical. The more detailed technical requirements were promulgated (except for land disposal) after this study was completed, on April 16, 1981.

- Part 265, Interim Status Standards For Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. This Part establishes the requirements applicable to facilities between the time of application for a permit and final disposition of the application.

These two Parts apply to treatment, storage, and disposal facilities. Certain requirements, e.g., for security, apply to all facilities. Other requirements are based upon the waste management function being performed, e.g., storage as opposed to treatment or disposal. Still other requirements are based on the properties of the hazardous waste being managed.

Not all facilities handling hazardous wastes are subject to Parts 264 and 265. These regulations do not apply to the treatment, storage, or disposal of wastes excluded from Part 261. Publicly owned treatment works also fall outside the hazardous waste obligations and requirements. Ocean disposal is governed by regulations promulgated under the Marine Protection, Research, and Sanctuaries Act, except for on-shore treatment and storage prior to vessel loading, which is subject to the hazardous waste regulations.

b. Specific Requirements

Part 265 establishes minimum operating, maintenance, financial, and general requirements for existing facilities during the interim status period. A facility that complies with these requirements need not comply with the Part 264 regulations until final administrative disposition of the permit applications.

The titles of the Subparts of Part 265 containing specific provisions are listed below to provide a brief overview of the contents of this regulation.

Subpart B — General Facility Standards
Subpart C — Preparedness and Prevention

Subpart D — Contingency Plan and Emergency Procedures
Subpart E — Manifest System, Recordkeeping, and Reporting
Subpart F — Groundwater Monitoring
Subpart G — Closure and Post-Closure
Subpart H — Financial Requirements
Subpart I — Use and Management of Containers
Subpart J — Tanks
Subpart K — Surface Impoundments
Subpart L — Waste Piles
Subpart M — Land Treatment
Subpart N — Landfills
Subpart O — Incinerators
Subpart P — Thermal Treatment
Subpart Q — Chemical, Physical, and Biological Treatment
Subpart R — Underground Injection

The requirements apply to owners and operators of facilities. In the summaries below, the references are confined to "facilities" with the understanding that the obligations belong to owner/operators.

(1) General Facility Standards

- Each facility must apply to EPA for an identification number in accordance with notification procedures.

- Notice must be provided to EPA of the expected date of arrival of any foreign shipments. It is also required that a new owner/operator be notified of the requirements of Part 265 before any transfer of ownership or operation.

- Prior to treating or disposing of any hazardous waste, a facility must obtain the information necessary to treat, store, or dispose of the waste. This may include data from chemical and physical tests, data obtained from the generator, or existing published or documented data. Off-site facilities must determine whether shipments received match the identity specified on the manifest. The analyses must be conducted in accordance with a waste analysis plan, indicating analysis parameters and rationale, test methods, sampling methodology and frequency, generator analyses, and any additional analyses necessary. Further, the plan must show what tests will ensure that the received waste matches the manifested waste.

- Security must be provided for each facility, either through a constant surveillance system or an artificial or natural barrier that surrounds the active portion of the facility and controls entry. If the facility is located within a site meeting the security requirements, then the facility meets the requirements. Warning signs must also be posted.

- An inspection schedule must be developed and implemented, remedial actions taken as necessary, and records kept of the inspections. The records must be retained for at least three years.

- All facilities must provide means for personnel to acquire competence in hazardous waste management practices and procedures relevant to particular job assignments. This may be accomplished by formal or on-the-job training programs or demonstration of equivalent experience. Job descriptions and records of competence and the means by which it is achieved must be maintained for operating personnel. Furthermore, all personnel must be trained in contingency plan and emergency requirements and must be given an annual review and update of training and competence.

- Precautions must be taken to prevent accidental ignition or reaction of ignitable or reactive waste. Such precautions pertain also to the commingling of incompatible wastes.

(2) Preparedness and Prevention

- All facilities must be equipped with internal and external communication and alarm systems and control equipment. This equipment must be periodically tested and maintained. Aisle space must be maintained for fire protection, spill control, and decontamination equipment.

(3) Contingency Plan and Emergency Procedures

- A contingency plan must be developed to minimize damage in the event of a discharge or release of waste from the facility. A copy of the plan must be maintained at the facility, available to the EPA Regional Administrator upon request, and be filed with appropriate local officials and state and local emergency response teams that may be called upon to provide emergency services. The plan should be detailed, including arrangements with local authorities to coordinate emergency responses.

- During operating hours, at least one designated person with specific operating and reporting responsibilities must be available to coordinate emergency responses. Following an emergency, the coordinator must ensure that the facility is ready to resume operations, and must file a written report on the emergency with the EPA Regional Administrator.

(4) Manifest System, Recordkeeping, and Reporting

- Facilities need to establish and maintain a system for receiving and retaining manifests for shipments received. Acceptance and receipt of the shipment must be acknowledged on all manifest copies. The original is to be returned to the generator, one copy is provided to the transporter, and one copy is retained for three years. Significant discrepancies between the manifest description and the actual shipment must be reconciled. If the discrepancy cannot be reconciled, a report must be submitted to the EPA Regional Administrator.

- An operating record must record wastes accepted, the handling method, and the location of disposal or storage, together with the results of the required analyses, reports of incidents, and monitoring data. Following closure, the owner/operator must submit records to EPA and the local land use authority showing locations and quantities of wastes.

- Each facility must submit an Annual Report identifying the generator(s), quantity, and disposal method of each hazardous waste managed in that year. The report must also include required monitoring data.

- If a facility accepts unmanifested hazardous waste not excluded from the regulatory program, it must be reported to the EPA Regional Administrator within 15 days.

- Facilities must also report any emergency event, groundwater contamination data, and anticipated closure.

(5) Groundwater Monitoring

- A facility with a surface impoundment, landfill, or land treatment activity must install, maintain, and operate a groundwater monitoring system unless it can demonstrate that there is low (or no) potential for groundwater contamination. The system must consist of at least one up-gradient and three down-gradient wells.

- At least semi-annually, samples must be collected and analyzed to check for groundwater contamination. An annual analysis must be done for groundwater quality.

- An outline of a groundwater quality assessment program must be prepared, together with an implementation plan. If analysis shows significant deviation from water quality standards, the facility must notify EPA and appropriate state and local authorities of the potential effect on groundwater quality. If EPA so orders, the facility must implement the assessment plans, report the results, and recommend remedial measures.

- Records of all analyses of samples, groundwater surface elevations, and related evaluations must be maintained. During the first year, quarterly monitoring reports must be submitted to EPA. In subsequent years, including the post-closure period, annual reports are required.

(6) Closure and Post-Closure

- Closure requirements apply to all treatment, storage, and disposal facilities. Each facility must develop a closure plan, to be amended whenever operating circumstances change. The plan must be followed in closing the facility. Closure ordinarily must be completed within six months of the final receipt of waste. All equipment must be disposed of or decontaminated and the closure certified by a registered professional engineer.

- Post-closure requirements apply only to disposal facilities and surface impoundments closed as landfills. These facilities must develop a post-closure plan, to be amended whenever operating circumstances change. The plan must address groundwater monitoring and reporting and maintenance of monitoring and waste containment systems. Post-closure care is ordinarily required for 30 years following closure. Post-closure use of land cannot disturb final cover, liner(s), etc. unless the disturbance is necessary for remedial action, or is necessary to property use and will not increase the potential hazard to human health or the environment. Following closure, each owner/operator must submit survey plats to EPA and the local land use authority. The plats must indicate the location and dimensions of disposal areas. Finally, the owner/operator must record a notation on the deed that the land has been used to manage hazardous waste.

(7) Financial Requirements

- States and the Federal government are exempted from financial requirements.

- All facilities must estimate the cost of closing the facility in accordance with the closure plan. The cost estimate must be modified when operating circumstances change, and on each anniversary of these regulations to account for inflation. Each owner/operator must have evidence of financial means to meet the estimated cost of closure.

- Disposal facilities must also estimate the cost of post-closure monitoring and maintenance in accordance with the post-closure plan. The cost estimate must be modified when operating circumstances change, and on each anniversary of these regulations to account for inflation. Each disposal facility owner/operator must have financial means to meet the estimated cost of post-closure monitoring and maintenance.

(8) Use and Management of Containers

- Containers must not leak and must be compatible with the waste, unless they are lined.
- Storage containers must be kept closed except when adding or removing wastes.
- Areas where containers are stored must be inspected at least weekly.
- Containers of ignitable or reactive waste must be more than 15 meters from the facility's property line.
- Wastes must not be placed in the same container with, or in an unwashed container that previously held, an incompatible hazardous waste.

(9) Tanks

- Construction materials for tanks and their liners must be compatible with the waste managed. If hazardous waste flows into a tank continuously, the tank must be equipped to stop the flow in the event of a leak or overflow.
- To protect the structural integrity of the tank, waste analysis, trial tests, and daily inspections must be performed and the results recorded.
- Uncovered tanks must be operated to ensure a minimum of 60 centimeters of freeboard.
- In general, ignitable and reactive waste must not be placed in the same tanks unless special precautions are taken. The same precaution applies to incompatible wastes and materials.
- At closure, all hazardous waste must be removed from tanks.

(10) Surface Impoundments

- Every surface impoundment must have a minimum of 60 centimeters of freeboard. Hazardous waste that could cause ruptures, leaks, etc. may not be placed in surface impoundments.
- Earthen dikes must have protective covers to minimize wind and water erosion and to preserve structural integrity.
- To assure the adequacy of the impoundment, waste analysis, trial tests for new wastes to be chemically treated, and weekly inspections must be performed and the results recorded.

- Special requirements apply for ignitable and reactive wastes and for incompatible waste(s) in the same surface impoundment.

- The closure plan must indicate whether the surface impoundment will be closed as a treatment or storage facility, or whether it will be closed as a landfill. In the former case, wastes and liquids must be removed. If the impoundment is closed as a landfill, then the requirements for landfill closure must be observed.

(11) Waste Piles

- Protections are required to assure that waste dispersal does not occur from waste piles and that incompatible wastes are not mixed.

- External runoff must be diverted from the pile and collected. A waste pile must be constructed on an impermeable base, compatible with the waste.

- In general, ignitable and reactive wastes must not be stored in piles.

(12) Land Treatment

- Direct runoff from a land treatment facility must be managed as a hazardous waste.

- Waste analysis must determine the concentration of heavy metals and of the substance for which the waste is listed as hazardous.

- Food chain crops may not, in general, be grown on the treated area of a land treatment facility unless the facility can demonstrate that hazardous waste constituents will not be transferred to the crop, or will not occur in higher concentrations at the facility than in the region.

- A plan for monitoring the zone of aeration must be developed and implemented.

- Records must be kept on application dates, quantities, and locations; monitoring results for the zone of aeration; monitoring and testing of food chain crops; and monitoring or analysis for developing or implementing the closure plan.

- The closure and post-closure plans must address numerous technical factors in the control of leaching of contaminants, contaminant runoff, and airborne particulates.

- Ignitable, reactive, and incompatible wastes may not, in general, be land treated, unless special requirements are met.

(13) Landfills

- Runoff must be directed from the active portions of a landfill, and be collected and analyzed for hazardous content. The owner/operator must take measures to prevent the wind dispersal of hazardous waste.

- The owner or operator must maintain in the operating record the location, dimensions, and contents of each disposal cell.

- Ignitable, reactive, and incompatible wastes must not, in general, be placed in a landfill. Containerized waste may not be landfilled. Bulk liquid waste and noncontainerized waste having free liquids may only be put in landfill with a liner and leachate collection and removal system.

- Specific technical objectives exist for closure and post-closure plans for landfills and for post-closure maintenance and monitoring.

(14) Incinerators

- The incinerator must be in normal operating condition before waste is added.

- A sample from each shipment of waste must be inspected before incineration. Any waste not previously burned must be analyzed further to determine its heat value, halogen and sulfur content, heavy metal concentration, and organic toxicant concentration.

- The facility must inspect and monitor combustion and emission control instruments every 15 minutes. Emissions must be observed hourly and all operating and emergency shutdown controls and system alarms must be inspected daily.

- At closure, all residues must be removed from the incinerator and disposed of appropriately.

(15) Thermal Treatment

These regulations apply to thermal treatment systems other than incinerators.

- A thermal treatment process must be in normal operating condition before wastes can be added.

- If the facility treats any new waste with thermal treatment, it must perform a waste analysis to determine the characteristics of the waste.

- The facility must inspect temperature and emission control instruments at 15-minute intervals, stack plume emissions hourly, and the complete treatment system daily.

- Wastes may not be burned in the open, unless they are explosive.

(16) Chemical, Physical, and Biological Treatment

These regulations apply to treatment other than in tanks, surface impoundments, landfills, and land treatment facilities.

- The owner/operator must not manage wastes that could cause the treatment system to rupture, leach, corrode, or otherwise fail. There are special requirements for ignitable, reactive, and incompatible wastes.

- If hazardous waste flows continuously into a treatment system, the system must have a means to stop the process and prevent overflow.

- If the facility treats a new or different waste, or uses a new or different process, it must perform analyses and trial tests (or obtain documented data) that show the treatment technique to be safe. The facility must record results of the analyses, tests, etc.

- Spill control, safety equipment, and monitoring data must be inspected and recorded daily. The physical treatment system and surrounding area must also be inspected at least weekly.

- At closure, the facility must remove all hazardous waste and hazardous waste residues from treatment processes and equipment.

(17) Underground Injection

A facility disposing of hazardous waste by underground injection is subject to all of the requirements of Part 265 except for the regulations discussed earlier with respect to closure, post-closure, and financial requirements. Because of the unique characteristics of underground injection, the latter areas are currently under study by EPA and any further requirements will be added later.

5. PERMITTING PROCEDURES FOR WASTE MANAGEMENT FACILITIES

a. General Requirements

RCRA Section 3005 requires the establishment of a permitting scheme and forbids the treatment, storage, or disposal of hazardous waste except in accordance with a permit. In general, the regulatory scheme created by the RCRA Subtitle C requirements uses a licensing approach. All facilities subject to the hazardous waste regulatory program are required to have a permit for lawful operation.

The requirements for treatment and disposal included in the permitting of facilities are in the Section 3004 regulations (Part 264). The administrative and procedural requirements relating to the permitting process are in Parts 122 (Program Requirements) and 124 (Procedures for Decision Making). Both Parts were promulgated in final form on May 19, 1980. These Parts, together with Parts 123 and 125, represent a consolidated approach to the permit requirements of the Hazardous Waste Management Program, the Underground Injection Control Program under the Safe Drinking Water Act, the National Pollutant Discharge Elimination Program, and the Section 404 Dredge and Fill Program under the Clean Water Act. The intent of the consolidated approach is to minimize the administrative costs for those facilities required by the different regulatory schemes to have two or more permits.

The permitting process provides the legal nexus that assures and enforces compliance with the technical requirements and standards. That is, compliance must be demonstrated in order to obtain the permit to commence and maintain waste management operations; each permit is subject to terms and conditions that assure continuing compliance.

To allow for start-up considerations, the regulations take an "interim" approach. Facilities in operation at the time of the effective date of the regulations are phased into the permitting scheme through a two-step process. The initial step is intended to achieve an "interim status," with the subsequent step leading to full compliance. New facilities must meet full compliance in a single administrative processing exercise.

b. Specific Requirements

(1) Obligation to Obtain Permit

All facilities must be in a permitted status to operate. Different types of facilities require different types of administrative processing.

- Existing facilities will pursue a two-step application process. The initial step involves submitting Part A of the application and maintaining the Part 265 interim status standards until EPA completes administrative action.

- New facilities that plan to start construction after the effective date of these regulations will make a single application.

- Health care facilities licensed by a state are covered by provisions for storage, sterilization, incineration, or treatment of hazardous waste generated by the facility.

- Permits by rule — Under this approach, EPA will promulgate an administrative rule that automatically permits the facilities involved and relieves them of the permitting obligations discussed here. The kinds of facilities to be covered by this procedure are special wastes (facilities managing only cement kiln dust, utility waste, phosphate rock waste, uranium and other mining waste, or gas and oil drilling muds and production brines) and ocean-disposal barges or vessels.

- Emergency authorization may be issued in the event of an immediate hazard to human health or the environment to allow management of a waste not covered by the existing permit status. This is a limited authorization, nonrenewable, and not to exceed 90 days, and applies only to facilities with a permitted status.

Confidential treatment of information submitted pursuant to the permit process is available and must be claimed at the time of submission.

(2) Fulfillment of Permitting Requirements

Permitting requirements include compliance with technical, operating, and financial standards. They also include additional requirements imposed by the proposed regulations for Part 122, e.g., submission of topographical maps, geologic and hydrologic details, and data on climatic conditions that enable evaluation of permit applications.

The Part A application is due within six months of the promulgated date of the regulations, with the more complex Part B due at a later date to be established by the appropriate EPA regional Administrator for each particular facility.

The regulations provide a waiver procedure for unnecessary information pertaining to compliance with the Section 3004 requirements. The waiver must be sought by the applicant with written justification and is intended to reduce permit application costs, because it allows elimination of unnecessary or inappropriate requirements.

(3) Preparation and Filing of Application and Administrative Review

This step involves documenting compliance with the interim status standards. The potential for public hearings, disputes as to needed standards, etc. may inject possible additional cost considerations, uncertainties, and time delays, however.

The regulations create a public participation process designed to fulfill "due process" considerations, but to minimize protracted proceedings. For example, public notices of applications and proposed permit issuance are intended to solicit written comments. Reliance is placed on staff evaluation and determinations; hearings are discretionary with the EPA Regional Administrator based on a perception of significant public interest.

(4) Permit Issuance

The regulations provide that EPA can impose appropriate terms and conditions and schedules of compliance on any permit issued. These conditions and schedules will follow the existing requirements and will be used primarily during the start-up period as a mechanism to provide time and opportunity for existing facilities to attain full compliance while continuing to operate. New facilities will need a permit before construction starts and approval by the EPA Regional Administrator is required before operations may start.

APPENDIX B

UNIT COSTS

APPENDIX B
UNIT COSTS

1. INTRODUCTION

Generators and disposers will incur incremental costs for a number of waste management activities that they must undertake in complying with the provisions of the ISS. These activities are: treatment/disposal, recordkeeping and reporting, monitoring and testing, administration, training, contingency plan, and closure and post-closure fund. This chapter discusses the methodologies used for estimating the incremental cost of these activities. In this analysis an incremental cost is a cost incurred to meet the new regulations over and above any costs incurred for waste management activities prior to 1976.

In general, the approach used in this analysis has been to estimate costs on a unit basis; a unit cost is the cost of an individual compliance activity such as one waste analysis, initial personnel training at one waste generator plant, or closing one cell of a secure landfill. These costs are used to estimate the total cost of compliance for the industry segments covered in this analysis. Appendix H shows sample calculations of the cost of compliance.

This appendix is organized by types of compliance activity. The identifying codes for the cost formulas and cost values refer to the initial-run computer identifications shown in Table V-1 in Chapter V and to the subsequent-run formulas (those with "I-" prefixed to the code shown in Appendix I. References to the appropriate RCRA sections and regulations are given in Table V-3.

Unit compliance costs were estimated for the required activities and equipment by preparing preliminary design information and using it as a basis for cost estimation. Most costs were developed by Pope-Reid Associates, Inc., using such sources as Means, Richardson, and Caterpillar Tractor Co., in-house data, and telephone interviews with suppliers. The costs were reviewed for their reasonableness by Arthur D. Little, Inc.

2. UNIT WAGE RATES

Labor costs for compliance with the ISS are stated in terms of person-hours for tasks defined or induced by the regulations. Although labor cost actually varies by region, industry, size of company, and other factors, sample wages were collected for selected job categories.

Appropriate job titles, job descriptions, and the associated base wage rates were selected from published sources* and matched with the descriptions of specific

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*AMACOM, Executive Compensation Service, Eighth Edition 1979-80. U.S. Department of Labor, Bureau of Labor Statistics, *National Survey of Employment and Earnings*, October 1979.

duties and responsibilities of personnel involved in ISS compliance tasks. The fully burdened hourly rates were then calculated, using a 100% overhead application and a 25% burden rate for pension and other benefits. The fully burdened hourly rates and the accompanying job descriptions for each applicable job title are described below.

a. Clerical

File Clerk/Typist — 1978 Rate: $9.00/hr. Sorts, codes, and files unclassified material by simple subject matter and headings, or partly classified material by finer subheadings. Prepares simple related index and cross-reference aids. As requested, locates clearly identified material in files and forwards material. May perform related clerical tasks required to maintain and service files.

Performs one or more of the following: copy typing from rough or clear drafts; routine typing of forms, insurance policies, etc.; setting up simple standard tabulations; or copying more complex tables already set up and spaced properly.

b. Supervisory

Supervisor — 1978 Rate: $27.50/hr. Under general supervision of a senior project engineer or a higher level engineering or research executive, plans, conducts, and supervises research, design, development, or manufacturing engineering assignments, normally involving several smaller or less important projects or one major project. Estimates manpower needs and schedules work to meet completion dates and technical specifications; coordinates and supervises engineers and technicians assigned to projects; maintains liaison with various divisions; reviews progress and evaluates results; makes changes in methods, design, or equipment where necessary. Generally operates with appreciable latitude for unreviewed action or decision.

c. Technical

Chemical Engineer I — 1978 Rate: $23.50/hr. Independently evaluates, selects, and applies standard engineering techniques, procedures, and criteria, using judgment in making minor adaptations and modifications. Assignments have clear and specified objectives and require the investigation of a limited number of variables. Performance at this level requires developmental experience in a professional position, or equivalent graduate level education. May supervise or coordinate the work of drafters, technicians, and others who assist in specific assignments.

Chemist/Chemical Engineer II — 1978 Rate: $29.00/hr. Under general supervision, plans, conducts, and directs analytical research and development work involving one or more projects where the technical problems involved customarily require the application of advanced knowledge of a particular field of chemistry. May be required to utilize or adapt new methods of procedure, necessitating considerable originality or ingenuity. Directs activities of other professionals and technicians assigned to project. Generally operates with appreciable latitude for unreviewed action or decision.

Truck Driver — 1978 Rate: $13.50/hr. Under administrative direction, has manifest responsibilities for all hazardous waste materials from their point of pickup to final disposal site; insures timely physical delivery of said substances; handles details of any problems or spills en route; inspects his vehicle prior to and after transport and informs administration of defective equipment.

3. TREATMENT/DISPOSAL UNIT COSTS

a. Runoff Control

Runoff control costs for a typical facility were estimated in a similar manner to fencing costs (see Section 8, Contingency Costs, below). Only land treatment and landfills require runoff control. For surface impoundments, the requirement of the regulations is met by the inherent design characteristics of the impoundment, i.e., dikes, and this analysis has therefore not addressed this requirement as an ISS cost. For land treatment, runoff control was assumed to be provided for the entire active area; for landfills, runoff control was assumed only for the active cell. No cost was assigned for treatment of the runoff. Runoff would be pumped or hauled to a wastewater treatment plant.

The cost of runoff ditches was estimated at $6.80 per linear foot, including all costs and fees. Sumps and sump pumps were estimated at $2100 and $1000 each, respectively.* The following formulas were used to estimate runoff control costs for a facility:

- Land Treatment (TR-1**, I-TR-1): $\$ = 3100 + 27\sqrt{60x}$
- Landfill (TR-2, I-TR-2): $\$ = 3100 + 27\sqrt{127(x)^{0.651}}$

In both formulas x equals metric tons (MT) of waste per year. The same methodology was used to calculate the perimeter of runoff systems for land treatment and landfills as was used to calculate fencing costs. The figure 27 is the product of $6.80/linear foot times the perimeter. Table B-1 shows costs for typical systems.

TABLE B-1

SAMPLE RUNOFF CONTROL COSTS

Size (MT/yr)	Cost ($) Land Treatment	Cost ($) Landfill
10,000	24,000	9,200
20,000	32,700	10,700
50,000	49,900	13,400

Source: Pope-Reid Associates, Inc., and Arthur D. Little, Inc.

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*Pope-Reid Associates, Inc., estimates based on Caterpillar Tractor Co. 1979; and Means 1979.

**Formula number.

b. Annual Closure of Single Landfill Cell

See discussion Section 9 below on closure costs.

c. Off-Site Costs

See discussion in Appendix C for off-site disposal prices, and discussion under Section 5, Monitoring and Testing Costs, below, for waste sampling and analysis.

4. RECORDKEEPING AND REPORTING COSTS

Recordkeeping and reporting costs are associated with several ISS requirements. These costs fall into three categories:

- Waste Generators (Section 3002). ID Code application and EPA notification; for off-site disposers, preparation and filing of manifests, preparation of Annual Reports and Exception Reports, and storage of all reports.

- Transporters (Section 3003). ID Code application, EPA notification of waste type, and manifest filing.

- Disposers (Sections 3004 and 3005). ID Code Application and EPA notification; preparation of Annual Report, maintenance of training records, operating log, groundwater monitoring results, and, for commercial TSDFs, manifest handling, exception reporting, and storage of such records.

This section presents the unit costs for these activities used in the cost analysis.

a. Waste Generators

Waste generators must apply for an ID Code and notify EPA that they are generators of hazardous waste. This one-time activity was assumed to cost (RR-1):

Technical:	1 hour	@ $29.00	$29.00
Clerical:	1/2 hour	@ $9.00	4.50
Total			$33.50

A generator must prepare and sign a manifest for each shipment of waste sent to off-site disposal. The generator must file the manifests and the signed copy returned to the generator by the end-point facility so the information is retrievable for the Annual Report. The annual cost of manifest signing, handling, preparation, and filing was assumed to be (RR-5):

Technical:	5 hours	@ $29.00	$145.00
Supervisory:	5 hours	@ $27.50	137.50
File Space			20.00*
Total			$302.50

Generators disposing of their waste off site must prepare an Annual Report summarizing the manifests and submit it to the EPA. Generators who treat, store, or dispose of waste on site are exempt from this specific requirement, but must submit a similar report, as required under Sections 3004 and 3005. The annual cost of this report was assumed to be (RR-3, I-RR-3):

Technical:	2 hours	@ $29.00	$58.00
Clerical:	1 hours	@ $9.00	9.00
Total			$67.00

If a signed copy of a manifest is not returned to the generator from the TSDF within 35 days, the generator must contact the transporter and/or the owner or operator of the designated facility to determine the status of the hazardous waste shipment. Within another 10 days the generator must send an Exception Report to the EPA Regional Administrator if the signed manifest has not yet been returned. The cost of this report was assumed to be (RR-2, I-RR-1):

Technical:	1/2 hour	@ $29.00	$14.50
Clerical:	1/2 hour	@ $9.00	4.50
Total			$19.00

It was also assumed that this cost would be incurred only infrequently, i.e., once in every 20 shipments.

Each manifest, Annual Report, and Exception Report must be stored for three years. The annual cost of this activity was estimated at (RR-4):

Clerical:	10 hours	@ $9.00	$ 90.00
File Space			20.00
Total			$110.00

b. Transporters

Transporters must also apply for an ID Code and notify EPA of the wastes they transport. Since transporters do not conduct an initial determination of waste type, this step will take longer to complete than it would for a waste generator. Costs (one-time) were assumed to be:

Technical:	2 hours	@ $23.50	$47.00
Clerical:	2 hours	@ $ 9.00	18.00
Total			$65.00

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*Arthur D. Little, Inc., "Characterization of Hazardous Waste Transportation and Economic Impact Assessment of Hazardous Waste Transportation Regulations. Report to U.S. EPA, August 1978.

In this calculation a different hourly wage rate was assumed for technical personnel to reflect the wage rates in the trucking industry.

Transporters must retain a copy of each manifest for three years. These annual costs are assumed to be:

Clerical:	12 hours	@ $9.00	$108.00
File Space			20.00
			$128.00

These transportation costs were not included in the incremental compliance costs.

c. Disposers

Recordkeeping and reporting under the provisions of Sections 3004 and 3005 parallel the provisions of Section 3002, with two exceptions. First, there are additional requirements for generators who dispose on site and thereby undertake a wider range of activities than generators who dispose off site. Second, commercial TSDFs are a special subset with more requirements, since they both dispose on site and perform manifest handling for their incoming shipments.

The initial cost for notifying EPA that the party is a disposer* of hazardous waste is assumed to be (RR-11):

Technical:	1 hour	@ $29.00	$29.00
Clerical:	1/2 hour	@ $9.00	4.50
Total			$33.50

Part A of the permit application to be submitted to EPA must contain a topographical map of the area, a scale drawing of the facility, a description of facility processes and wastes, and a description of operating plans. Some of the Part A cost is included under administrative costs, e.g., the cost of organizing the activities and preparing background information. The initial cost for Part A under Recordkeeping and Reporting is assumed to be:

		Initial Practice (RR-12)		Subsequent Practice (I-RR-12)
Supervisory:	20 hrs @ $27.50	$ 550.00	6 hrs	$165.00
Technical:	40 hrs @ $29.00	1160.00	10 hrs	290.00
Clerical:	15 hrs @ $ 9.00	135.00	4 hrs	36.00
Total		$1845.00		$491.00

Training records, including job descriptions and information on training of each employee, must be stored for three years. The annual cost for this is assumed to be (RR-6):

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*For disposers who are also generators, this is a second notification to EPA.

Clerical:	12 hours	@ $9.00	$108.00
File Space			20.00
Total			$128.00

Detailed disposal records must be kept for each shipment or batch of waste disposed, including location, characteristics, volume, and date of shipment. Based on an average site capacity of 20,000 MT/year, this annual cost was assumed to be:

		Initial Practice (RR-8)		Subsequent Practice (I-RR-4)
Technical:	24 hrs @ $29.00	$ 696.00	12 hrs	$348.00
Clerical:	72 hrs @ $ 9.00	648.00	24 hrs	216.00
File Space:		20.00		20.00
Total:		$1364.00		$584.00

Preparation of the Annual Report represents a small expenditure. It was assumed to be (RR-7):

Technical:	1 hour	@ $29.00	$29.00
Clerical:	1 hour	@ $ 9.00	9.00
Total			$38.00

Records of groundwater monitoring tests must be compiled and stored for three years. This annual cost was assumed to be (RR-9, I-RR-5):

Technical:	8 hours	@ $29.00	$232.00
Clerical:	3 hours	@ $ 9.00	27.00
File space			20.00
Total			$279.00

Incinerator facilities do not have to compile groundwater monitoring records. They must, however, keep records of incineration efficiency and monitoring results to be reported to EPA twice a year. This annual cost was assumed to be (RR-10, I-RR-6):

Technical:	16 hours	@ $29.00	$464.00
Supervisory:	4 hours	@ $27.50	110.00
Clerical:	6 hours	@ $ 9.00	54.00
File Space			20.00
Total			$648.00

5. MONITORING AND TESTING COSTS

Sections 3001 and 3004 of the regulations contain monitoring and testing requirements having incremental ISS compliance costs. For most of the requirements, the attributable costs can vary over a wide range because actual costs will depend on the nature and number of chemical species present in the waste. The estimated low value is representative of a chemically simple waste managed on site using in-house analysis. The estimated high value is representative of a complex waste managed off site and analyzed by an independent laboratory. In this study, the typical value is used to determine the costs of compliance. This value was selected to reflect the chemical composition of a "typical" waste and is not usually the mid-point of the range.

a. Section 3001

Section 3001, which defines hazardous wastes, requires generators to make an initial determination of whether a waste is hazardous, either by checking against the lists provided by EPA in Parts 261.31 and 261.32 of the regulations, or by testing to see if the waste has one or more of the hazardous characteristics listed in Subpart C (261.21-24).

If the waste is listed, the generator may test to show that his waste is not hazardous. If the waste is not listed, the generator may test if he suspects it may be hazardous, according to the characteristics of ignitability, corrosivity, reactivity, or EP toxicity. The tests to meet these requirements vary widely in complexity and cost.

Table B-2 shows unit cost estimates, i.e., costs for individual analyses, for all the tests mentioned in the ISS.

TABLE B-2

UNIT COSTS FOR TESTING OF HAZARDOUS WASTE CHARACTERISTICS

Test Characteristic	Cost per Analysis
Ignitability	$ 25-50
Corrosivity[a]	30-100
Reactivity	50-100
EP Toxicity[b]	
• Sampling	50-250
• Extraction Procedure	150-250
• Heavy Metals	150-250
• Pesticides and Herbicides	200-500
Toxicity (Organic)[c]	500-2500

a. Only liquid wastes are tested for corrosivity. The corrosivity characteristic does not apply to solids.

b. Extraction Procedure toxicity is as defined in the regulations, Section 261.24.

c. Only a small number of generators will have listed wastes which they wish to test by this procedure.

Source: Arthur D. Little, Inc., estimates based on in-house experience and estimates obtained from independent laboratories

The ISS do not require any generator to test his waste; he can simply declare that it is hazardous. Conversely, some generators may believe that their waste is not hazardous although it has been listed in the regulations. This study estimates the fraction of generators who will undertake various levels of testing on the basis of a qualitative evaluation of the hazardous wastes identified for each industry and the number of wastes with specific characteristics, i.e., ignitability, corrosivity, reactivity, and EP toxicity. To calculate the costs of compliance, each waste stream identified in Chapter IV has been assigned a test code (A, B, or C) in the computer model used in this analysis (Table B-3). The average testing cost, multiplied by the fraction of the generators assumed to use the test, can then be specified for each waste; this is the cost used in the analysis. Table B-3 shows these estimates as well as the unit costs (range and average) for each level of testing. A substantial number of generators are expected to undertake the less expensive testing to prove they do not have a hazardous waste. Fewer generators are expected to attempt the more expensive tests because the reduced disposal costs will not offset the higher testing costs.

TABLE B-3

ASSUMED TESTING PRACTICES BY GENERATORS TO MEET REQUIREMENTS OF ISS SECTION 3001
(MT-1)

Characteristic of Waste	Test Code	Testing Cost (per waste) ($) Range	Testing Cost (per waste) ($) Average	% of Generators Who Will Test		Average Testing Cost ($)
Ignitability (I) Reactivity (R) Corrosivity (C)	A	25-100	50	90	=	45
EP Toxicity (E)	B	320-1,250	800	75	=	600
Toxicity (Organic) (T)	C[a]	500-2,500	800	50	=	400
High Impact Industries	NA	–	800	50	=	400

a. Only a small number of waste generators will have listed wastes that they wish to test with this procedure.

Source: Arthur D. Little, Inc., estimates based on in-house experience and estimated obtained from independent laboratories.

b. Section 3004

Section 3004 applies to operators of TSDFs, who are required to carry out tests on waste shipments to the extent necessary to ensure correct management of the waste under RCRA regulations. Monitoring to detect contamination of groundwater is also required for landfills, surface impoundments, and land treatment facilities. Soil monitoring is required for land treatment facilities, and incinerators must monitor the combustion process.

(1) Testing

TSDF operators must test each new waste for the chemical and physical parameters that must be known in order to manage the waste in accordance with the regulations. An existing analysis, i.e., one done to meet the requirements of state agencies, may satisfy the 3004 requirements as may a waste analysis carried out by the generator to meet the requirements of Section 3001. The regulations indicate, however, that a test to meet the requirements of 3001 may not necessarily be adequate to provide correct waste management. Also, some generators will declare their waste hazardous as listed and not carry out a 3001 analysis.

Analysis of hazardous characteristics and hazardous constituents will be similar to that shown in Table B-2. The cost can vary from $25 to $2500 and for a typical waste will average an estimated $800. TSDF operators must also inspect each shipment and collect and analyze a sample of the waste. The cost for this "inspection" is estimated at $25-100, with an average of $50. The costs of the initial and repeat analysis and shipment analysis are included in the off-site treatment and disposal price (See Appendix C).

It has been assumed that a full shipment contains 20 MT of waste, but those generators with less than 80 MT annually must still ship their waste every 90 days to avoid being classed as a storage operation under Section 3004. Therefore, the minimum number of shipments is assumed to be four per year.

The initial analysis must be repeated as often as necessary to ensure that it is accurate, and at a minimum under the following conditions:

- when the process generating the hazardous waste is changed, and
- when the inspection of a shipment indicates that the waste received by an off-site facility does not match the accompanying manifest.

For generators with no more than 80 MT annually, it has been assumed that the initial analysis will be repeated every two years. For generators with 80-160 MT annually, the period between analyses will be 1-2 years based on the quantity of waste, and for generators with more than 160 MT annually, the analysis will be repeated each year.

Annual testing costs on a per-waste basis have been calculated using the above assumptions with the formulas shown in Table B-4. Thus, the minimum annual testing cost is $600, increasing proportionally with the waste quantity for disposal. Conversely, the cost of testing per MT of waste sent for disposal increases rapidly for generators with the smaller amounts of waste.

On-site TSDFs may handle their waste continuously and thus may not be able to identify specific shipments. Since most on-site TSDFs will be disposing of large quantities of waste, it is assumed that they will conduct a minimum analysis ($50) weekly and a detailed analysis ($800) annually, making the total cost per disposal technology for an on-site generator $3400 annually, independent of waste volume (MT-4, I-MT-3).

TABLE B-4

ESTIMATE OF ANNUAL TESTING COSTS

	Range	Average
Initial (and repeat) analysis	$60-2,500	$800
Each shipment analysis	$25-100	$ 50

Weight of each shipment: 20 MT (metric tons)

Number of shipments (S) = Waste quantity (W) ÷ 20

For $W < 80$; Annual Cost \$ $= 800/2 + (4 \times 50) = 600$ (TR-11, I-TR-11)

For $80 < W < 160$; Annual Cost \$ $= 800 \cdot \frac{W}{160} + 50\,S$ (TR-12, I-TR-12)

For $W > 160$; Annual Cost \$ $= 800 + 50\,S$ (TR-13, I-TR-13)

COST OF TESTING AT OFF-SITE TSDF AS A FUNCTION OF GENERATOR WASTE VOLUME

MT of Waste/Year/Waste Stream	Cost of Testing ($)	Cost of Testing/ MT of Waste ($)
10	600	60
40	600	15.0
80	600	7.50
90	675	7.50
110	825	7.50
130	975	7.50
160	1,200	7.50
200	1,300	6.50
300	1,550	5.17
500	2,050	4.10
2,000	5,800	2.90
5,000	13,300	2.66
10,000	25,800	2.58

Source: Arthur D. Little, Inc., estimates based on in-house experience and informal estimates obtained from TSDF operators.

A written waste Analysis Plan must be developed for each waste and must specify as a minimum:

- The parameters for which the waste will be analyzed and the rationale for the selection of those parameters,
- The test methods that will be used to test for those parameters, and
- The sampling method that will be used to obtain a representative sample.

In order to develop the Analysis Plan, it will be necessary to carry out analyses to verify that the test methods selected are satisfactory for that waste. This will require tests similar to the detailed analyses previously described but with replicate samples and a higher degree of accuracy.

The costs are estimated as follows (MT-1a):

Check of selected analytical methods: $100-2500; average: $1600.
Preparation of Analysis Plan:

Technical:	40 hours	@ $29.00	$1160.00
Supervisory:	4 hours	@ $27.50	110.00
Clerical:	16 hours	@ $ 9.00	144.00
Total Cost for Development of Analysis Plan (one time)			$3014.00

(2) Groundwater Monitoring

Groundwater monitoring applies to landfills, surface impoundments, and land treatment facilities. The ISS require a minimum of four monitoring wells (including a background well). The background well is to be located hydraulically up-gradient from the facility, with the others hydraulically down-gradient from the facility. Arthur D. Little, Inc., assumed that an average of two or three of the wells would require sampling at two depths, i.e., a total of six or seven samples per site.

Costs for installing groundwater monitoring wells vary with the geology of the site and the extent to which the location and depth of groundwater have been previously determined. Typically, a number of exploratory wells must be dug and tested at each site in order to map the site in detail. From the results of this survey, the final monitoring wells can then be located and drilled.

Data in an EPA study of groundwater monitoring* indicated that the capital costs for site exploration, drilling, and installation of each monitoring well range from about $1800 to $8500, with an average of $5000 (1977 dollars). To adjust the figures to 1979 levels, the capital costs should be increased by about 27%, i.e., to $2300-10,800, with an average of $6400 per well. Four wells will cost $9200-$43,000, with an average of $25,600. About 10% of all disposal sites will have no groundwater or will lie over a saline aquifer and will therefore not require a groundwater monitoring system. To account for this factor, the capital costs of groundwater monitoring were reduced on a per-site basis by 10%. Thus, capital costs for a groundwater monitoring system (four wells) range from $8300 to $38,900, with an average of $23,000 (MT-2, I-MT-1).

The ISS require the following analyses of groundwater:

- Parameters listed in the Primary Drinking Water Standards (see Table B-5);

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*Geraghty & Miller, Inc. "Ground-Water Monitoring," Report to U.S. EPA, Contract 68-01, 3703, May 1978.

TABLE B-5

EPA INTERIM PRIMARY DRINKING WATER STANDARDS

Parameter	Maximum Level (mg/l)	Parameter	Maximum Level (mg/l)
Arsenic	0.05	Lindane	0.004
Barium	1.0	Methoxychlor	0.1
Cadmium	0.01	Toxaphene	0.005
Chromium	0.05	2,4-D	0.1
Fluoride	1.4-2.4	2,4,5-TP Silver	0.01
Lead	0.05	Radium	5 pCi/l
Mercury	0.002	Gross Alpha	15 pCi/l
Nitrate (as N)	10	Gross Beta	4 millirem/yr
Selenium	0.01	Turbidity	1/TU
Silver	0.05	Coliform Bacteria	1/100 ml
Endrin	0.0002		

Note: Turbidity is applicable only to surface water supplies.

Source: 45 *Federal Register* May 19, 1980 Page 33257, Appendix III.

- Parameters establishing groundwater quality (chloride, iron, manganese, phenols, sodium, and sulfate); and

- Parameters indicative of groundwater contamination (pH, specific conductance, total organic carbon, total organic halogen).

The unit costs assumed for these analyses are shown in Table B-6.

All three types of analysis must be carried out quarterly in the first year. In subsequent years, Primary Drinking Water Standards and groundwater quality parameters must be checked annually and groundwater contamination parameters semi-annually. Average annual costs for groundwater monitoring, based on the above requirements, are calculated in Table B-6.

(3) Incinerators

Incinerator waste must be analyzed for heating value (Btu content), halogen and sulfur content, heavy metals, and hazardous organic constituents.

The annual cost to complete these analyses will range from $500 to $4000, with an average of $2000. Existing instruments to monitor the combustion process must be checked every 15 minutes. It is assumed that additional process and supervisory hours will be required to meet this requirement, although in most cases it will be less than one full-time employee. The annual operating costs for this procedure will range from $4000 to $14,000, with an average of $9000. (There are no requirements for installation of any additional instruments to monitor combustion or waste-destruction efficiency under the ISS.)

TABLE B-6

UNIT COSTS FOR ANALYSIS OF GROUNDWATER SAMPLES

	Range ($)	Average ($)	Annual Frequency	
			First Year	Subsequent Years
Unit Costs for Analysis				
Parameters listed in primary drinking water standards	50-1300	800	4	1
Parameters indicative of groundwater quality	65-165	120	4	1
Parameters indicative of groundwater contamination	55-250	150	4	2

	Annual[b]	First Year Added[c]
Annual Operating Costs[a]		
Sampling and analysis costs *per site*	1220	3080

a. Amortization of capital costs (average $23,000 per site) is not included.

b. This figure corresponds to unit cost formula MT-6.

c. This figure corresponds to unit cost formulas MT-3 and I-MT-2.

Source: Arthur D. Little, Inc., estimates.

The total annual testing and-monitoring costs associated with incineration will range from $4500 to $18,000 per site, with an average of $11,000 (MT-5, I-MT-4).

(4) Land Treatment

Land treatment facilities must analyze for pH, hazardous metals, and any other hazardous components in soil samples. Land treatment facilities must also collect and treat (and analyze) surface water that has been in contact with the treated area. The facilities must also monitor soil core water in the zone of aeration using lysimeters (average cost: $1600 per analysis). A minimum of five samples annually must be obtained from the lysimeters and the soil cores.

Each land treatment facility has been assumed to be dedicated to a single waste and the cost per analysis will range from $50 to $1300 (average $800) for pH and hazardous metals and $250-1500 (average $800) for analysis of other hazardous constituents. Therefore, the total cost per analysis will be $300-2800 (average $1600).

Table B-7 summarizes the expected frequency of monitoring and the anticipated annual cost. Groundwater monitoring, as described earlier, is also required for land treatment facilities; these costs are included to give an estimated total cost of $4900-69,000 with an average of $39,900 (MT-7, I-MT-6a). More frequent groundwater monitoring is required during the first year of operation, adding $3300 to the cost (MT-6a, I-MT-7).

TABLE B-7

ANNUAL MONITORING COSTS FOR LAND TREATMENT FACILITIES

	Range	Average
Size (Acres)	20-60	35
Surface Water		
Frequency of Analysis	5-15	10
Annual Cost ($)	1,500-28,000	16,000
Soil Analysis		
Frequency of Analysis	5-10	7
Annual Cost ($)	1,500-19,600	11,200
Zone of Aeration Monitoring		
Frequency of Analysis	5-10	7
Annual Cost ($)	1,500-19,600	11,200
Sampling Costs ($)	180-420	290
Groundwater Monitoring[a] Cost ($)	225-1,965	1,250
Total Annual Costs ($)	4,905-69,585	39,940

a. Additional costs for groundwater monitoring in the first year increase the annual costs to $5,360 to $74,480 with an average of $43,200.

Source: Arthur D. Little, Inc., estimates.

6. ADMINISTRATIVE COSTS

a. Introduction

Administrative costs, unlike costs of recordkeeping/reporting and some other activities, are often implicitly, rather than explicitly, associated with the ISS. Some of these costs are evident in the language of the regulations, e.g., maintaining the operating log of a TSDF or ensuring that manifest-handling procedures are carried out. Other costs are not explicit but are necessary to obtain compliance, e.g., the cost of documenting test results or administrative procedures associated with annual reporting.

For this analysis, these implicit costs are divided into three broad categories: systems design, administration, and documentation. Systems design covers the initial cost of setting up technical, clerical, and/or mechanized systems to comply with the requirements of the ISS. These costs are one-time costs and are considered expenses rather than capital items. Administration reflects both the involvement of administrative personnel and the incremental supervisory time needed to manage the activities of clerical and technical staff. These costs do not involve capital budget items; hence, unit costs are identified as either "initial" or "recurring." Documentation covers the time spent by technical and clerical personnel in reviewing and writing up the results of monitoring analysis and test procedures.

Certain costs are fixed with respect to an individual plant, i.e., the activities involve the expenditure of labor only once. Other costs are considered fixed with respect to a means of disposal; plants may have more than one type of disposal facility located on site and would therefore have to incur labor costs for each means of disposal. Where necessary, administrative costs are identified as per type of disposal facility. The remainder of the costs in the system are per-plant costs.

b. Waste Generators (Section 3001)

All waste generators must spend some administrative time upon initial receipt of the regulations to institute a formal compliance review and conduct an initial assessment of potential hazardous waste. This initial cost for review for each waste stream was estimated to be (AD-2):

Technical:	2 hours	@ $29.00	$58.00
Clerical:	2 hours	@ $ 9.00	$18.00
Total			$76.00

This cost is incurred once for each hazardous waste stream generated.

Administrative time is also necessary to examine the EPA list of waste streams published in the *Federal Register*, and document the conclusions reached about the hazardous nature of waste streams. If testing is performed, the results must be written up. If the generator chooses to designate waste as hazardous, or to conclude that his wastes are not hazardous through the declaration procedure, the conclusions must also be documented for each waste stream generated. The one-time cost for documentation activities for off-site disposers was assumed to be (AD-1):

Technical:	3 hours	@ $29.00	$ 87.00
Clerical:	3 hours	@ $ 9.00	27.00
Total			$114.00

Each plant must also review its files each year with respect to the nature and volume of hazardous waste generated. As the list of wastes is updated by EPA, the *Federal Register* notice should be reviewed. The annual cost of these review activities was estimated to be (AD-3, AD-4):

Supervisory:	2.2 hours	@ $27.50	$60.50
Technical:	1 hour	@ $29.00	29.00
Clerical:	1 hour	@ $ 9.00	9.00
Total			$98.50

c. Waste Generators — Off-Site Disposal (Section 3002)

The generator who will be disposing of waste off site faces the greatest responsibilities under 3002. The supervisory costs for establishing the procedures to be followed, which are incurred initially, are (AD-6):

Supervisory:	12 hours	@ $27.50	$330

Off-site disposers must devise an adequate manifest handling system, a container labeling system, and a process for handling exception and annual reporting. The generator's personnel must have some on-the-job training to familiarize themselves with these procedures. The initial cost of designing these systems was estimated at (AD-5):

Technical:	19 hours	@ $29.00	$551
Clerical:	16 hours	@ $ 9.00	144
Total			$695

On an annual basis, manifest preparation and container labeling must be carried out by clerical personnel, overseen by supervisory staff. The cost of these activities was assumed to be (AD-7, AD-8):

Clerical:	(20 minutes/manifest)	@ $ 9.00/hour = $3.00/shipment
Supervisory:	(2 hours/month)	@ $27.50/hour = $660/year

d. Transporters (Section 3003)

Many of the regulations under 3003 have been subsumed under similar Department of Transportation hazardous materials transportation regulations. The sole administrative cost remaining under RCRA is the hazardous waste manifest handling required by the truck driver, who must obtain an authorized signature and ensure that the contents of the shipment conform with the manifest description.

All costs are on a per-shipment basis. Drivers of tank trucks require 5 minutes for a signature, since they do not have to take a physical inventory of their shipment; 75% of hazardous waste shipments are in tank trucks. The remaining shipments (25%) are drummed and require 10 minutes for a signature. Exceptions are cases where a document cannot be signed promptly because the manifest description differs from the actual contents. This was assumed to happen in 15% of the shipments (AD-9, I-AD-2, AD-10, I-AD-3).

Signature:	5 or 10 minutes/driver	@ $13.50/hour = $1.13 or $2.25 plus
	15 minutes/exception	@ $13.50/hour = $3.39

e. On-Site Disposal (Section 3004)

On-site disposers and commercial TSDFs are regulated under Section 3004. The regulation requires preparation of closure and post-closure plans and a waste analysis plan. Costs for these one-time activities were estimated at:

Closure and Post-Closure Plan (AD-11):

Technical:	40 hours	@ $29.00	$1160
Clerical:	30 hours	@ $ 9.00	270
Total			$1430

Waste Analysis Plan (AD-12):

Technical:	90 hours	@ $29.00	$2610
Clerical:	32 hours	@ $ 9.00	288
Total			$2898

Most generators that ship wastes off site for treatment and disposal will utilize tanks to hold wastes for shipment, for settling and dewatering, or for neutralization or other simple treatment. If the storage period exceeds 90 days or if the tanks are used for treatment, then the generator will be required to comply with a number of the compliance activities under Section 3004. Each off-site generator must develop an inspection plan (initial cost of $100) (AD-15) and carry out inspections routinely at a cost of $1500 per year (AD-16).

f. Other Administrative Activities

The other practices discussed in the regulation, i.e., reporting, inspecting, and setting up the operating log, must be reviewed and, if necessary, implemented. Costs (initial) for these activities were estimated at (AD-13):

Systems Design:

Technical:	35 hours	@ $29.00	$1015.00
Clerical:	15 hours	@ $ 9.00	$ 135.00
Total			$1150.00

As under Section 3002, the administrative personnel of the disposer must review the regulation, devise a path to achievement of compliance, and commission the tasks that will set this process in motion. It is assumed that in this task the facility has had some assistance and prior review through trade association or state/local community activities. This initial cost was assumed to be (AD-14):

Regulation Review:

Supervisory:	15 hours	@ $27.50	$412.50

Each facility must also carry out an inspection of the premises, checking for leaks, weather damage, flooding, and other conditions, and note the findings on the operating log. The annual cost of these activities for the first waste practice of a single site was estimated as (AD-17):

Regular Inspection:

Technical:	25 hours	@ $29.00	$725.00

For each additional waste management practice, the cost is estimated as (I-AD-4):

Regular Inspection:

Technical:	5 hours	@ $29.00	$145.00

g. Part A Permit Application (Section 3005)

The ISS require that each facility file Part A of the permit application by November 1980. The permit application must contain a topographical map of the area, a scale drawing of the facility, a description of facility processes and wastes, and a description of operating plans. The administrative portion of the cost of preparing this application was assumed to be:

		Initial Practice (AD-18)	Subsequent Practice (I-AD-5)
Supervisory:	40 hrs @ $27.50	$1100.00	10 hrs $275.00
Technical:	20 hrs @ $29.00	580.00	5 hrs 145.00
Clerical:	15 hrs @ $ 9.00	135.00	4 hrs 36.00
Total		$1815.00	$456.00

7. TRAINING COSTS*

Training of employees is required under Section 3004 of the RCRA regulations. An estimate of the cost for developing a training course has been updated to 1979 dollars for this report.** This initial cost of $10,175 has been assumed for every onsite disposer (TG-1).

The regulations require that all employees involved in the hazardous waste management process, not only technical personnel, be trained. For small facilities, 10 employees were assumed to be the population eligible for training (TG-2);*** for large facilities, the number assumed was 15 (TG-3).**** The annual cost for training, including an employee's time and materials, was assumed to be $300 per person.

8. CONTINGENCY COSTS

Contingency costs, covered in Sections 3003, 3004, and 3005 of the regulations, include the unit costs of reporting spills and incidents, or of any technical equipment used to reduce the probability of an incident (Security Costs). Contingency equipment includes fire control equipment, protective clothing, and communications equipment. There is also a requirement to prepare a contingency plan. The basis for these unit costs is discussed in this section.

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*See Section 2 (Unit Wage Rates) of this appendix for discussion of procedure for estimating the labor costs used in this analysis.

**Battelle Columbus Laboratories. "Cost of Compliance with Hazardous Waste Management Regulations." Report to U.S. EPA, 68-01-4360, 1978.

***Foster D. Snell, Inc. "Potential for Capacity Creation in the Hazardous Waste Management Service Industry," Report to U.S. EPA, PB 257-187, 1975.

****U.S. EPA, Office of Solid Waste, 1978.

a. Incident Reporting (Section 3003)

The requirements for incident reporting under the ISS parallel the Department of Transportation hazardous materials regulation. No incremental cost resulting from the ISS has therefore been assumed.

b. Contingency Equipment (Section 3004)

Costs used in this analysis for contingency equipment are based on those in a report sponsored by EPA.* The figures in the report varied from $15,600 to $84,160 per site; since many of the expenditures projected by IR&T are no longer necessary under the ISS, all on-site disposers were assumed to incur a one-time capital cost of $10,000 (CP-1). For the second or further additional waste management practices of a given facility, the cost is reduced to $7500 (I-CP-1).

(1) Treatment Tanks (Section 3004)

Tanks used for treatment or storage incur costs for security and for spill containment. Security costs of $66 for two signs to be posted for outdoor tanks are incurred as initial costs by off-site disposers (CP-5). Spill containment costs are incurred as capital costs by off-site disposers as follows (CP-4):

Annual Waste Rate (MT/yr)	Tank Size (000 gallons)	Capital Cost** ($)
0-2,000	10	1,038
2,001-5,500	30	1,786
5,501-20,000	50	2,309
>20,000	100	3,559

(2) Fencing (Section 3004)

All facility owners/operators must prevent unauthorized entry of people or livestock onto the active portion of their facilities. This analysis assumes that a fence and gate meet this security requirement for all facilities.

This analysis assumes that all incinerators were fenced prior to RCRA and the ISS will not require any incremental expenditures for fencing incinerators. Fencing costs for the other three types of facilities were estimated by conceptually designing a facility and estimating the perimeter to be fenced, assuming that only active portions of a site would be fenced. For a surface impoundment, the entire impoundment was assumed to be fenced; for a landfill, only the active cell.

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*International Research and Technology, Inc., "Hazardous Waste Management Issues Pertinent to Section 3004 of the Resource Conservation and Recovery Act of 1976," Final Report to U.S. EPA, September 1978.

**Each disposer is assumed to have two tanks. Estimates provided by EPA staff, Office of Planning and Management, 1980.

The cost of fencing was estimated to be \$12 per linear foot and \$325 per gate installed, including all costs and fees.* The following formulas were used to estimate facility fencing costs with one gate each:

- Surface Impoundment (CP-3, I-CP-2):
  $\$ = 325 + 48\sqrt{43{,}560\ (1.37)\ (y^{0.9})}$

  Derivation of the formula: The surface impoundment is assumed to be rectangular, with the length twice the width. The expression $\sqrt{43{,}560\ (1.37)\ (y^{0.9})}$ was derived to estimate the average length of a side of the impoundment as function of its acreage; 43,560 is the number of square feet in an acre and y is the area of the impoundment in acres. The "average" length of a side is multiplied by four to determine the perimeter and by 12 to determine the cost of the fence $(4 \times 12 = 48)$. The cost of one gate (\$325) is added.

- Land Treatment (CP-2, I-CP-3): $\$ = 325 + 48\sqrt{60x}$

  Derivation of the formula: It was assumed that 800 metric tons (MT) of waste per year (as dilute slurry) is spread on one acre in land treatment. The expression 60x was derived to determine the number of square feet of land treatment area required to be fenced as a function of annual disposal rate. A 10% allowance was made for a buffer zone; x equals the annual disposal rate in metric tons (1 acre = 43,560 sq. ft./800 x 1.1 = 60). The land area was assumed to be square and the expression $\sqrt{60x}$ determines the length of a side as a function of annual disposal rate. Four times the side length is the perimeter; twelve times the perimeter is the cost of the fence. The cost of a gate is added.

- Landfill (CP-6, I-CP-4): $\$ = 325 + 48\sqrt{127\ (x)^{0.651}}$

  Derivation of the formula: The depth of a landfill cell was assumed to increase as annual disposal capacity increases. The expression $127(x)^{0.651}$ was derived to determine the area of the cap of a cell as a function of disposal capacity. The cell is assumed to be square; therefore $\sqrt{127\ (x)^{0.651}}$ is the length of a side. Four times the side length is the perimeter; twelve times the perimeter is the cost of fencing. The cost of a gate is added.

Using these formulas, where y equals surface area of disposal areas in acres and x equals MT of waste per year, sample costs of fencing for typical installations are shown in Table B-8.

Many facilities already have fences that meet the ISS security requirements. There is little quantitative data available on the extent to which fencing is used by industry, however. For each of the high-impact industries, the technical contractor

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*Pope-Reid Associates, Inc.

TABLE B-8

SAMPLE FENCING COSTS

	Cost ($)		
	Surface Impoundment	Land Treatment	Landfill
Size (acres)			
1	12,100		
5	24,500		
10	33,400		
(MT/yr)			
10,000		37,500	11,200
20,000		52,900	13,900
50,000		83,500	18,600

Source: Pope-Reid Associates, Inc., and Arthur D. Little, Inc., estimates.

made estimates by plant of the need for fencing. For other industries, assumptions were made by Arthur D. Little, Inc. The need for fencing for these other industries is summarized below by management practice:

Percent Requiring Fencing:

Incineration	Landfill	Land Treatment	Surface Impoundment
0	100	100	50

c. Contingency Plan (Section 3005)

Part A of the disposal permit for on-site disposers requires submission to EPA of a Contingency Plan. The plan must show how the facility personnel intend to mitigate potential threats to human health and the environment resulting from fires, explosions, or releases of hazardous waste. This plan requires the facility owner/operator to contact each local fire/police authority and record whether the authority has agreed to assist in the event of an emergency.

Costs of developing a Contingency Plan (a one-time cost) were estimated as follows (CP-7):

Supervisory:	30 hours	@ $27.50	$ 825.00
Technical:	15 hours	@ $29.00	435.00
Clerical:	10 hours	@ $ 9.00	90.00
Total			$1350.00

9. CLOSURE COSTS

Closure activities are required (Section 3004) for the four types of disposal facilities (secure landfill, land treatment, surface impoundment, and incineration) discussed in this report.

a. Landfills, Land Treatment, and Surface Impoundments

To estimate costs for closure for all disposal facilities except surface impoundments, conceptual designs were made for each type of facility. For landfills, depth was assumed to vary with cell capacity. Table B-9 shows the important dimensions for range of sizes of square-shaped landfill facilities. Two types of caps can be used to close a landfill; the basic differences in design are the materials used as the impervious layer. One type uses a 20-mil PVC membrane; the other, a 12-inch thick layer of clay. Table B-10 lists the basic design features of caps and Figure B-1 presents conceptual designs for the two cover systems.

TABLE B-9

DIMENSIONS OF RANGE OF LANDFILLS

Annual Capacity (MT)	Annual Capacity (m^3)	Depth (m)	Top-Side Length (m)	Area of Top (acres)
1,000	833	2	33	0.27
10,000	8,330	4	67	1.11
25,000	20,800	5	91	2.05
50,000	41,700	6	115	3.27
100,000	83,300	8	142	4.98

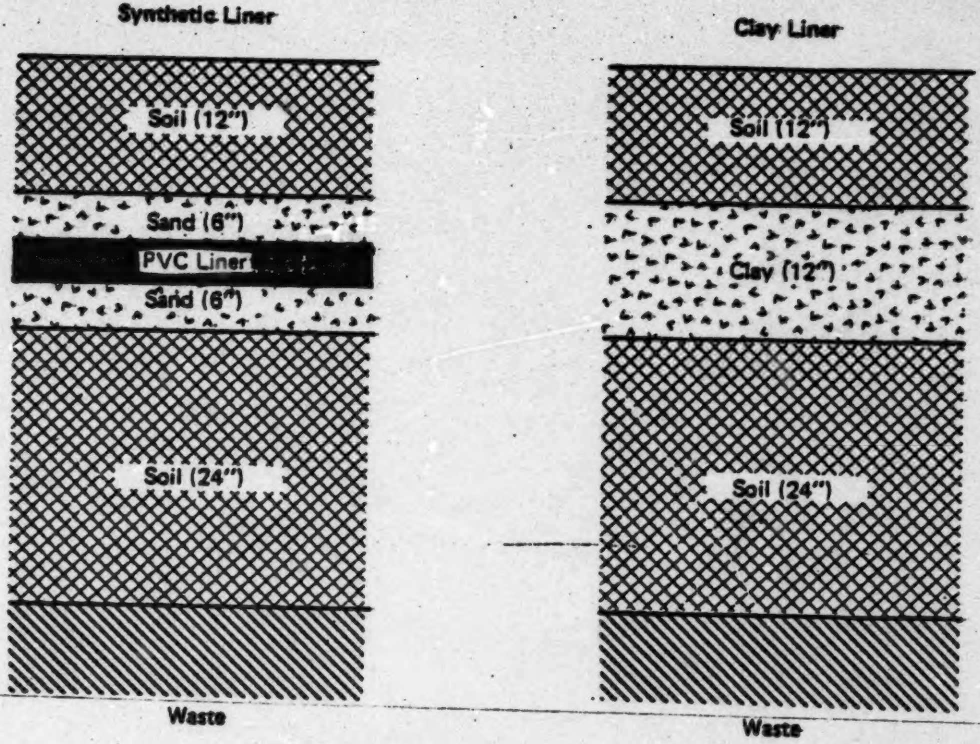
Source: Pope-Reid Associates, Inc.

TABLE B-10

DESIGN FEATURES OF LANDFILL CAPS

	PVC Liner	Clay Liner
Stabilized Base	12-in. fill	12-in. fill
Buffer Layer	6-in. sand	NA
Impervious Membrane	20-mil PVC	12-in. clay
Buffer Layer	6-in. sand	NA
Soil Cover	24-in. fill	24-in. fill
Runoff Collection System	Yes	Yes
Revegetation	Yes	Yes

Source: Pope-Reid Associates, Inc.


Synthetic Liner
Soil (12")
Sand (6")
PVC Liner
Sand (6")
Soil (24")
Waste
Clay Liner
Soil (12")
Clay (12")
Soil (24")
Waste

Source: Arthur D. Little, Inc.

FIGURE B-1 LANDFILL COVER DESIGNS

The size of surface impoundments is reported as surface area acreage. No additional conceptual designs had to be prepared to size closure caps for these facilities. Rather, the same two types of cap designs assumed for closure of landfills were assumed for closure of surface impoundments, but were re-costed to conform to the reported surface impoundment dimensions.

For land treatment, the application rate (MT of waste/acre/yr) is most important. An average rate of 800 MT/acre/yr was used to determine the acreage of a land treatment facility. Closure design was simple; either the treatment area is revegetated, or 8 inches of contaminated soil is removed and replaced with fill and the area is then revegetated.

The unit closure costs for landfills and surface impoundments were determined by estimating the quantity of materials required for closing a facility based on the design criteria discussed above and the following unit installed cost data:*

20-mil PVC	\$ 5.00/m^2
clean sand	\$ 6.25/m^3
soil/fill (available on site)	\$ 3.00/m^3
clay (available on site)	\$ 3.50/m^3
runoff collection ditch	\$18.00/m
revegetation	\$1000/acre

These cost estimates include excavation, spreading, compaction, and grading, as required. The quantities of soil and clay assumed to be required were increased by 25% and the quantity of sand by 10% to allow for compaction and surplus. The PVC membrane was increased in surface area to allow for proper anchoring. Allowances of 10% each were made for the costs of both engineering and contingency.

The closure costs for land treatment facilities were estimated at \$2000 per acre if only revegetation was required and \$65,000 per acre if top soil had to be removed* and disposed of in an off-site secure landfill.

After estimating the cost of closure of facilities of several sizes for each disposal method, i.e., clay or PVC, and revegetation alone or soil removal and revegetation, the following equations were developed to express closure costs as a function of capacity:

- Landfill: Clay $\$ = 174\,x^{0.575}$
  PVC $\$ = 283\,x^{0.597}$

where x = MT/yr

- Surface Impoundment: Clay $\$ = 60{,}480\,y^{0.982}$
  PVC $\$ = 101{,}010\,y^{0.947}$

where y = acres

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*Pope-Reid Associates, Inc.

- **Land Treatment:** **Revegetate only $\$ = 2.5x$**
  Remove soil and revegetate $\$ = 81.3x$

where x = MT/yr.

In estimating the "average" cost of closure it was necessary to estimate the number of facilities that would be closed by each method. For example, for landfills and surface impoundments, clay or PVC membranes could be used; for land treatment, soil may have to be removed before revegetation. Table B-11 presents the weighting factors used in determining average closure costs.

TABLE B-11

BASIS FOR DETERMINING AVERAGE TREATMENT AND DISPOSAL CLOSURE COSTS

Closure Activity or Material	Surface Impoundment	Land Treatment	Landfill
Clay Liner	75%	–	50%
PVC Liner	25%	–	50%
Revegetate	–	90%	–
Remove Soil	–	10%	–

Sources: Arthur D. Little, Inc., and Pope-Reid Associates, Inc.

On the basis of these assumptions the following formulas were developed to estimate average closure costs. The formulas reflect application of the assumed percentage weighting of usage to the formulas previously discussed.

- Landfill (I-TR-3, CF-11, I-CF-10):
  $\$ = 0.5\,(174\,x^{0.575} + 283\,x^{0.597})$

where x = MT/yr

- Surface Impoundment (CF-13, I-CF-12)
  $\$ = 0.75\,(60{,}480\,y^{0.962}) + 0.25\,(101{,}010\,y^{0.947})$

where y = acres

- Land Treatment (CF-12, I-CF-11):
  $\$ = 0.10\,(81.25\,x) + 0.9\,(2.5\,x)$

where x = MT/yr.

Typical closure costs are shown in Table B-12 using the previously developed equations. Closure costs for a landfill cover only the closure of the final cell. The costs incurred in closing down a working cell on the average of once per year during the operating lifetime of the landfill are considered treatment and disposal costs.

TABLE B-12

SAMPLE TREATMENT AND DISPOSAL CLOSURE COSTS

	Cost ($)		
	Surface Impoundment	Land Treatment	Landfill
Size (acres)			
1	70,600		
5	336,000		
10	659,000		
(MT/yr)			
10,000		104,000	51,900
20,000		208,000	78,200
50,000		519,000	134,000

Source: Pope-Reid Associates, Inc., and Arthur D. Little, Inc.

Land treatment requires more surface area per MT of waste disposed than do landfills. Therefore, the land treatment closure cover costs are larger per unit of annual capacity than those for landfills (Table B-12).

In addition to these treatment and disposal closure costs, other costs (e.g., administrative, recordkeeping and reporting, monitoring and testing) are associated with decontamination of the surroundings, decommissioning, and certification. These costs are shown in Table B-13 for landfills and disposal impoundments. These other costs for land treatment are estimated to amount to $4245 (CF-5, I-CF-4).

b. Incineration of Liquid Wastes

The cost of incinerator closure was estimated on a worst-case basis where the unit is shut down with an inventory of unprocessed waste on hand. In this situation, the cost of closure would include both disposal of the inventory and decontamination of the facility. In such a case, it is necessary to ensure that the closure fund will pay for both tasks.

Estimates were made for the closure and decontamination of incinerators burning halogenated wastes (with scrubbers) or non-halogenated wastes (without scrubbers).

The rationale behind varying inventory by plant capacity is that larger plants would be more likely to have larger quantities of waste in storage, even with only a few days of inventory on hand, because of the size of their operation. Larger inventories allow them to operate continuously and to control the waste mix more efficiently, and therefore control its burnability. Small units, on the other hand, would have less opportunity to preserve operating flexibility with a low inventory containing several types of wastes.

TABLE B-13

OTHER CLOSURE COSTS
($)

A. Landfills[a]

	Capacity (MT/yr)				
	1,000	2,000	5,000	20,000	50,000
Other Costs[b]	1,725	1,955	2,255	3,795	6,900
Plans for Groundwater Monitoring[c]	450	450	450	450	450
Total	2,175	2,405	2,705	4,245	7,350

B. Surface Impoundments[d]

	Size (acres)		
	1	5	10
Other Costs[b]	1,725	1,955	2,255
Plans for Groundwater Monitoring[c]	450	450	450
Total	2,175	2,405	2,705

a. This portion of the table corresponds to unit cost formulas CF-2 and I-CF-2
b. International Research and Technology Corp. adjusted estimates.
c. Arthur D. Little, Inc., estimates.
d. This portion of the table corresponds to unit cost formulas CF-9 and I-CF-8.

On-site facilities were assumed to be able to operate efficiently at lower inventories than off-site facilities of the same capacity. On-site plants will generally burn a smaller variety of wastes and have better control over delivery. Table B-14 shows the inventories (expressed in days) used in this analysis as a function of plant capacity.

The estimated cost to burn the inventory includes all raw materials, utilities, labor, overhead, and capital charges.* The full cost was used to take into account the possibility that the facility had been abandoned and that a contractor was hired to close the facility. It was assumed that the contractor's fee would approximate the capital charges.

Table B-15 lists the closure and decontamination activities and costs assumed. Because incinerators will not vary greatly in physical size, and decontamination costs are more a function of the number of activities than the size of the equipment involved in the activity, decontamination costs were assumed to be held constant. Table B-16 shows sample closure costs for incinerators.

There are also other costs associated with decommissioning and certification. These costs are shown in Table B-17.

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*Pope-Reid Associates, Inc., and Arthur D. Little, Inc.

TABLE B-14

INCINERATOR INVENTORIES AS A FUNCTION OF PLANT CAPACITY[a]

Annual Capacity (MT)	Inventory (days)
1,000	35
5,000	25
8,000 (off-site)	30
10,000	20
20,000 (off-site)	30
20,000	10
50,000	5

a. All facilities are assumed to be capable of burning halogenated wastes except for the 20,000-MT (off-site) facility.

Source: Arthur D. Little, Inc., estimates.

TABLE B-15

INCINERATOR CLOSURE AND DECONTAMINATION ACTIVITIES AND COSTS

Activity	Cost ($)
Residue Disposal	9,600
Tank Cleaning	40,900
Wastewater Disposal	24,700
Sump and Line Draining	5,000
Contaminated Soil Removal	43,800
Warehouse Cleaning	1,500
Certification of Closure	700
Administration and Contingency	36,800
Total	$163,000

Source: International Research and Technology Corp. adjusted estimates.

TABLE B-16

SAMPLE INCINERATOR CLOSURE COSTS

Annual Capacity (MT)	Annual Operating Cost ($/MT)[a]	Inventory (Days)	Inventory (000 MT)	Closure Costs To Burn Inventory[b] (000 $)	Closure Costs Decontamination (000 $)	Closure Costs Total (000 $)
			(a) Halogenated Wastes			
1,000	566	35	35	60	163	223[c]
5,000	335	25	125	127	163	290
8,000[d]	375	30	240	346	163	509
10,000	289	20	200	175	163	338
20,000	277	10	200	148	163	311
50,000	207	5	250	157	163	320
			(b) Hydrocarbon Wastes			
1,000	311	35	35	33	163	196[e]
5,000	103	25	125	39	163	202
10,000	68	20	200	41	163	204
20,000	51	10	200	31	163	194
20,000[d]	59	30	600	136	163	299
50,000	42	5	250	32	163	195

a. Arthur D. Little, Inc., and Pope-Reid Associates, Inc., estimates.

b. $\frac{1000 \text{ (capacity)}}{330 \text{ (operating days)}} \times 35 \text{ (inventory)} \times \$566/\text{MT} = \$60{,}000$

c. These costs correspond to unit cost formulas CF-6 and I-CF-5.

d. For an off-site facility; all others were assumed to be on-site.

e. These costs correspond to unit cost formulas CF-7 and I-CF-6.

Source: Arthur D. Little, Inc.

TABLE B-17

OTHER CLOSURE COSTS FOR INCINERATORS

	Capacity (MT/yr) 1,000	5,000	10,000 ($)	20,000	50,000
Other Costs[a]	1,600	1,620	2,750	3,780	6,750

a. These costs correspond to unit cost formulas CF-8 and I-CF-7.

Source: International Research and Technology Corp. adjusted estimates.

c. Tanks

Closure costs were also estimated for tanks for treatment or storage of wastes used by off-site disposers.[*] These costs of decommissioning per tank are:

Annual Tonnage (MT)	Closure Cost (C_t) ($)
0-2,000	1,000
2,001-5,500	1,600
5,501-20,000	2,200
>20,000	4,400

The total closure cost per plant is based on the assumption of two tanks per plant plus a fixed $100 expense per site as follows (CF-4, I-CF-13):

Cost ($) = 2 C_t and 100.

10. POST-CLOSURE COSTS

The objective of post-closure monitoring is to identify any discharge of waste, leachate, or waste decomposition products into groundwater from disposal facilities at which wastes remain after final closure. Post-closure regulations (Subpart G of the regulations) apply to owners/operators of all disposal facilities.

The disposal facility's post-closure plan must specify the frequency of monitoring and maintenance activities. Within 90 days of closure, the owner/operator of a disposal facility must submit a survey plat to the local land authority and the EPA Regional Administrator, and must make a notation on the property deed or other instrument normally examined during a title search to indicate that the land has been used to manage hazardous waste and that its use is restricted under Section 265.117 of RCRA.

Post-closure care consists of maintenance, monitoring, including maintenance of monitoring and waste containment systems, and reporting the monitoring results. Under certain conditions, the EPA Regional Administrator may also require maintenance of security during the post-closure period. An owner/operator must provide post-closure care for at least 30 years from the date of completion of closure, unless the EPA Regional Administrator allows some or all of the requirements to be discontinued or altered. On the other hand, the EPA Regional Administrator may require the owner/operator to continue some or all of the requirements in the post-closure plan beyond 30 years.

Post-closure activities are required only for disposal sites, but they will vary with each of the following types:

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[*] U.S. EPA, Office of Solid Waste.

- *Landfill.* Soil integrity, vegetation, survey benchmarks, security fence, and monitoring wells must be maintained. Samples must be taken from monitoring wells and analyzed.

- *Surface Impoundment.* A surface impoundment could be closed like a landfill, in which case post-closure activities would be the same as for landfills. Alternatively, the impoundment could be dredged to remove all of the hazardous waste material. In this case, post-closure monitoring and care would not be necessary.

- *Land Treatment.* No post-closure activities for a land treatment facility were included in this analysis as it was assumed the wastes so treated would be detoxified.

- *Incinerator.* Incineration facilities are not disposal sites and thus will not require post-closure monitoring.

If other disposal methods are allowed for hazardous waste, e.g., underground injection, similar requirements would be applicable for those types of facilities.

Unit costs for post-closure maintenance were obtained from a study conducted by International Research and Technology Corp.* Unit costs for post-closure monitoring were estimated by Arthur D. Little, Inc., using the protocol described in Section 5 above (Monitoring and Testing Costs). For landfills and surface impoundments, the unit post-closure maintenance costs are for the same activities, and differ only with the land area to be covered. Monitoring costs are the same for all size facilities, except that costs for commercial (off-site) facilities are higher as a consequence of the more costly monitoring and analysis of well samples. Table B-18 illustrates the post-closure maintenance and monitoring costs for several different size on-site landfills. The IR&T report contains 1977 costs for facilities with annual capacities of 5000 cubic meters and 50,000 cubic meters. Arthur D. Little, Inc., inflated the costs to 1979 dollars and interpolated costs for other sizes.

The IR&T report developed costs of maintenance for different sized landfills in terms of annual capacity in cubic meters. Closure costs were developed for landfills in terms of annual capacity in metric tons. For several types of hazardous waste, a cubic meter of waste is roughly equivalent to a metric ton; therefore, in this analysis the maintenance cost per cubic meter of annual capacity was assumed to be equal to the maintenance cost per metric ton of annual capacity.

Table B-19 shows sample costs for surface impoundments of different sizes closed as landfills.

11. FINANCIAL REQUIREMENTS

The objective of the financial requirements under the ISS (Subpart H of the regulations) is to ensure that the owner or operator of each TSDF has sufficient

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*International Research and Technology Corp., "An Analysis of the Methods for Ensuring Continuity of Operation for Hazardous Waste Disposal Sites." Draft report to U.S. EPA, 1979.

TABLE B-18

SAMPLE ANNUAL POST-CLOSURE COSTS FOR LANDFILLS

Activity	Capacity (MT/yr)				
	1,000	2,000	5,500	20,000	50,000
			($)		
Maintenance[a]	$2,700	$3,120	$4,560	$10,780	$23,400
Monitoring[b]	1,250	1,250	1,250	1,250	1,250
	3,950	4,370	5,810	12,030	24,650

a. International Research and Technology Corp. estimates. Includes maintenance of soil integrity, vegetation, survey benchmarks, security fence, and monitoring wells.

b. Arthur D. Little, Inc., estimates. Includes sampling and analysis of monitoring well samples.

TABLE B-19

SAMPLE POST-CLOSURE COSTS FOR SURFACE IMPOUNDMENTS CLOSED AS LANDFILLS[a,b]

Activity	Impoundment Surface Area (Acres)		
	1	5	10
		($)	
Maintenance[c]	$2,600	$2,900	$3,120
Monitoring[d]	1,250	1,250	1,250
	$3,850	$4,150	$4,370

a. The post-closure trust fund contribution is 30 times the annual cost.

b. This table corresponds to unit cost formulas CF-10 and I-CF-9.

c. International Research and Technology Corp. estimates. Includes maintenance of soil integrity, vegetation, survey benchmarks, security fence, and monitoring wells.

d. Arthur D. Little, Inc., estimates.

funds to close the facility properly and that the owner or operator of each disposal facility has sufficient funds to provide post-closure monitoring and maintenance. Facilities operated by a state or the Federal government are exempted from the financial requirements.

a. Regulatory Requirements

By the effective date of the ISS, each TSDF must have an estimate of the cost of closing the facility in accordance with the closure requirements. This estimate must represent the maximum cost that would be incurred by closing at any point in the life of the facility, but allows for consideration of the costs of partial closures scheduled in the closure plan. This estimate must be adjusted whenever any major assumptions change, as well as annually to reflect the effects of inflation, using the GNP deflator.

By the effective date of the ISS, an owner/operator of a disposal facility must also have an estimate of the annual cost for post-closure monitoring and maintenance. This estimate must also be adjusted whenever any major assumptions change, as well as annually to reflect the effects of inflation.

Six months after EPA promulgates the financial requirements regulations, each owner/operator must have evidence of financial assurance for facility closure and post-closure care. Financial assurance must be demonstrated through the use of one or more of the following options:

- A trust fund, to be built up over the first twenty years (other periods have also been considered) of facility operation to cover the total estimated cost for closure and post-closure care;
- An irrevocable stand-by-type letter of credit in an amount equal to the total estimated cost for closure and post-closure care;
- Surety bonds either guaranteeing performance of closure and/or post-closure duties, or written in an amount equal to the total cost estimated for closure and post-closure care.

The proposed ISS included provisions for a revenue test applicable to municipalities and for a financial resource test and guarantees of resources applicable to private firms in order to provide financial assurance for closure and post-closure responsibilities. The EPA has deferred promulgation of both provisions. Thus, "[i]n planning how they will meet the financial responsibility today, owners and operators should not consider the revenue test, financial test, or self-insurance as available or imminently available options at this time."*

If a TSDF is in a state where existing hazardous waste regulations require owners/operators to provide financial assurance for closure or post-closure monitoring and maintenance, the state-authorized mechanism can be used, if it is one of the mechanisms described above or provides a similar degree of assurance.

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*46 *Federal Register*, January 12, 1981.

The alternative financial mechanisms described in the regulations were studied by IR&T under an EPA contract.* Each of the financial mechanisms has different costs, but there is also considerable uncertainty as to the availability of letters of credit and surety bonds to provide financial assurance or performance guarantees for closure and post-closure activities for any but large corporations.

The use of a trust fund would require that a TSDF owner/operator deposit each year an amount equal to the total closure or post-closure cost divided by the estimated facility life, but no less than 5% of the total value of the closure and/or post-closure monitoring and maintenance cost. Furthermore, the TSDF would be required to pay the institution that administers the trust a fee that will vary according to the dollar value of the fund, its location, and other factors. Based upon the IR&T study, the management fee could have a minimum level of about $500 and would generally be charged to the facility operator based on a percentage of the fund above that minimum. In this analysis, a simplified formula was used; all separate closure funds were charged $500 per year (CF-1).

A surety bond appears on the surface to be less costly than a trust fund on a present-value basis. The annual premium could be as low as 1.5-2% of the face value of the bond.* Such a bond requires collateral, however, and the amount needed varies with the nature of the collateral and the degree of risk entailed. Acceptable collateral could include marketable securities and other similar assets. The amount of collateral would have to be high enough that a drop in the market would not reduce the value of the collateral below the face amount of the bond. Also, the higher the business risk of the enterprise being bonded, the higher the collateral required, all other things being equal. A hazardous waste TSDF would be considered a higher risk by the surety than many other types of business. Thus, the use of a surety bond could result in a greater allocation of the TSDF's assets than use of a trust fund.

The letter of credit mechanism, which appears to be the cheapest alternative, requires the payment of a service fee to the lending institution. This mechanism, however, may be feasible only for large companies.

The trust fund approach has been used for the present analysis because it requires the fewest assumptions as to the availability of the prescribed guarantees in future financial markets.

b. Closure Trust Fund Contribution Cost

Closure and post-closure requirements are combined in a single trust fund. The contributions to this combined fund provide for expenses that will be incurred in the future. The unit costs of the combined fund are based on the technical costs developed above and the administrative cost. The annual cost is one-twentieth of the technical costs plus the administrative charge of $500. Examples of unit closure fund costs for the four major types of disposal facilities are shown in Table B-20. No post-closure activities are required for land treatment and incineration.

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*International Research and Technology Corp., op. cit.

TABLE B-20

COMBINED CLOSURE AND POST-CLOSURE FUND SIZE AND ANNUAL COST

A. LANDFILLS

	Capacity (MT/Yr)					
	1,000	2,000	5,500	10,000	20,000	50,000
Closure Fund	13,400	20,200	36,500	51,900	78,200	134,000
Post-Closure Fund	118,500	131,100	174,300	247.200	360,900	739,500
Annual Contribution (1/20)	6,595	7,560	10,540	14,955	21,955	43,675
Fund Management	500	500	500	500	500	500
Annual Cost	7,095	8,060	11,040	19,955	22,455	44,175

B. SURFACE IMPOUNDMENTS

	Impoundment Surface Area (Acres)		
	1 Acre	5 Acres	10 Acres
Closure Fund	70,600	336,000	659,000
Post-Closure Fund	115,500	124,500	131,100
Annual Contribution (1/20)	9,305	23,025	39,525
Fund Management	500	540	500
Annual Cost	9,805	23,525	40,025

C. LAND TREATMENT

	Capacity (MT/Yr)		
	10,000	20,000	50,000
Closure Fund	104,000	208,000	519,000
Annual Contribution (1/20)	5,200	10,400	5,950
Fund Management	500	500	500
Annual Cost	5,700	10,900	26,450

D. INCINERATION – HYDROCARBON WASTES

	Capacity (MT/Yr)				
ON-SITE	1,000	5,000	10,000	20,000	50,000
Closure Fund	196,000	202,000	204,000	194,000	195,000
Annual Contribution (1/20)	9,800	10,100	102,000	9,700	9,750
Fund Management	500	500	500	500	500
Annual Cost	10,300	10,600	10,700	10.200	10,250
OFF-SITE					
Closure Fund				299,000	
Annual Contribution (1/20)				14,950	
Fund Management				500	
Annual Cost				15,450	

Source: Closure Costs – Arthur D. Little, Inc., estimates based on data provided by Development Planning and Research Associates, Inc.
Post-Closure Costs – Arthur D. Little, Inc., estimates based on Tables B-18 and B-19.

The accounting principle of proper matching of revenue and expenses would appear to allow a TSDF to charge payments to the closure and post-closure funds against current revenues. Since the Internal Revenue Service may not allow contributions to closure and post-closure funds as tax-deductible expenses, a rigorous analysis of closure and post-closure fund contributions would include a cash outlay equal to the taxes attributable to interest earnings of the trust. Such a provision was not incorporated in the computer program. The reported costs understate the actual costs, but not to a significant degree.

The TSDF owner/operator will be reimbursed for closure costs to the extent of the closure fund after the facility is finally closed. The cost of post-closure monitoring and maintenance may be reimbursed from the trust funds in annual increments. To reflect the return of these funds at a future date, the net present value of the funds to be returned in the future was applied against the estimated fund size.

APPENDIX C

OFF-SITE WASTE DISPOSAL PRICES

APPENDIX C
OFF-SITE WASTE DISPOSAL PRICES

1. INTRODUCTION

The RCRA ISS will impose incremental compliance costs on off-site commercial facilities as well as on-site generator-operated facilities. The incremental costs for off-site disposal will be reflected in higher prices for commercial disposal. The change in the price of disposal is therefore an incremental cost of compliance for waste generators. This appendix presents the methodology for estimating this price change.

Prior to the passage of RCRA and the promulgation of hazardous waste management regulations, producers of hazardous waste had relatively inexpensive options available for off-site disposal at environmentally insecure disposal sites. The limited number of more secure disposal sites was under severe price pressure because of competition from lower-priced disposal outlets. A 1976 study showed a significant under-utilization of the disposal capacity then existing.*

With RCRA regulations in place, commercial disposal facilities and practices will be broadly upgraded, and many of the previously uncontrolled dumping outlets will be closed to waste generators.

The implication of this changed regulatory environment is that the price of disposal will be driven up at least by the added costs of compliance with the regulations. Moreover, the demand for permitted disposal outlets at pre-RCRA prices will be driven up and may significantly exceed the capacity of existing commercial disposal firms. An excess of demand over supply would result in value-based price increases higher than would be implied simply by the changed cost of off-site disposal resulting from the new regulations. The value of off-site disposal to a waste generator is the alternative cost of on-site disposal at the generating plant. In a supply-constrained market, the value of the disposal service to the generator will be more of a price determinant than the cost of providing the service. Actual supply and demand balances in specific regions of the country will depend on both existing disposal capacities in the area and enforcement practices of state and Federal regulating agencies. In the short run, a demand and supply imbalance will be difficult to correct because of local opposition to building new disposal facilities.

In this analysis, price changes were assumed to be cost driven; it has not been possible to estimate with any accuracy the magnitude of value-driven price changes. It is likely, particularly during the early years of the regulatory program, that prices will be higher than projected here. In the longer run, however, prices should return to the cost-driven level as supply and demand come into balance at profitability levels closer to historical industry averages. A sensitivity analysis was run (Chapter VI) to estimate the change in total compliance cost for all the 22 industries studied if off-site disposal prices were higher than the values used in this report.

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*Foster D. Snell, Inc., "Potential for Capacity Creation in the Hazardous Waste Management Services Industry," report to U.S. EPA, SW-127C, August 1976.

Current off-site waste disposal prices are a mixture of cost-based and value-based prices. The cumulative volume of land disposal off site is functionally related to disposal price in a form similar to that shown in Figure C-1. Some waste costs $50-80/MT for off-site disposal, while most waste costs $10-30/MT. Under the ISS, at least the lower part of the curve in Figure C-1 will shift to the right as a result of the increase in the cost of operating the facility. This change in price is applied to all off-site waste in the cost analysis of this report, although some generators are already paying the higher prices. These higher prices are RCRA induced, i.e., the incremental cost of RCRA is already reflected in them.

The incremental prices for off-site disposal are developed in this appendix using the unit costs previously developed (Appendix B) and the cost of capital values (see Appendix E).

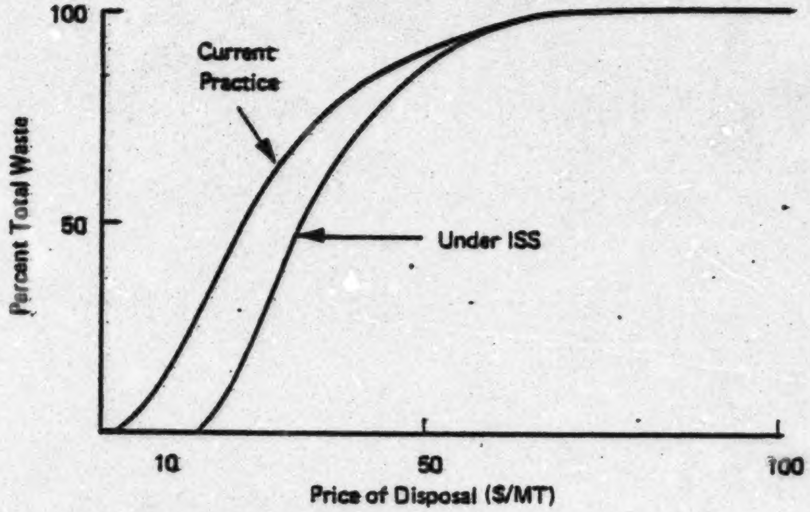
2. COMPLIANCE ACTIVITIES COSTED

Disposal of hazardous waste at commercial off-site facilities involves two categories of activities regulated by the ISS: transportation and treatment/disposal. Expressed as a cost per MT per mile transported, the ISS regulations should not impose material incremental compliance costs on hazardous waste transportation. The requirements for transportation are largely an adaptation of Department of Transportation regulations. The ISS cost analysis assumes that waste will be sent to the same disposal facilities prior to and after the ISS. Only when the facility standards are promulgated would there be changes in facility usage and ensuing changes in transportation patterns. Additional transportation costs will be important if waste must be transported farther when existing outlets are closed.

The full spectrum of disposal, closure fund, reporting, testing, and administrative requirements applicable to on-site disposal activities are also applicable to off-site facilities. The off-site costs for some categories are higher because of different assumptions about waste inventories, testing requirements, and administrative practices. The unit costs presented in Appendix B are used here to develop the off-site price values. Differences between on-site costs and off-site costs are noted.

3. UNIT OFF-SITE DISPOSAL PRICES

Estimation of incremental off-site disposal price includes identifying the capacity of the off-site facility, developing the applicable compliance costs, and estimating the corporate overhead and profit to be included in the disposal price. This analysis assumes that no major investments will be made in new disposal facilities under the ISS, and that current practices and facilities will continue to be used and upgraded only as necessary to comply with the ISS until the facility standards implementing Section 3004 of RCRA are defined. A consequence of these assumptions is that disposal currently on site has been assumed to continue on site under the ISS.



Source: Arthur D. Little, Inc.

FIGURE C-1 HYPOTHETICAL RELATIONSHIP OF CUMULATIVE OFF-SITE WASTE DISPOSAL TO DISPOSAL PRICE (Land Disposal)

Off-site disposal prices, excluding the cost of transportation, were estimated for facilities using eight different hazardous waste disposal technologies.

In selecting the capacity of the off-site facilities, two major factors were considered:

- Typical sizes of existing off-site TDSFs
- Economics of operation

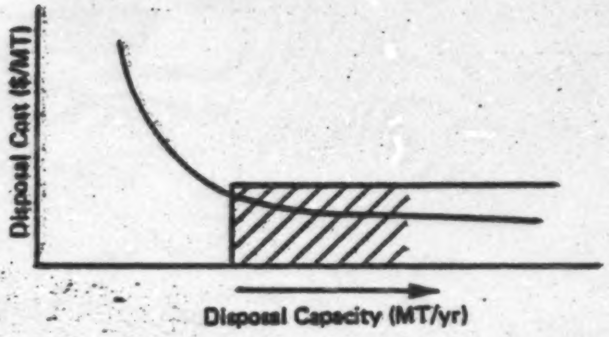
The disposal practices typically have a cost/capacity relationship as shown in Figure C-2. For this analysis, it was assumed that an economically viable off-site disposal company would have a capacity sufficiently large to fall in the shaded area of the curve shown in Figure C-2. Otherwise, a generator would choose to remain on site. The precise shape of the curve and the disposal capacity for off-site facilities vary by disposal technology.

Figure C-3 shows typical curves for open dumping and incineration. As can be seen, open dumping is relatively inexpensive and unit disposal costs do not vary greatly with capacity. As a result, most generators, regardless of size, will dump on site if possible. Off-site facilities would have to be very large and in close proximity to waste generators to be economically attractive.

Rotary kiln incinerators, on the other hand, are relatively expensive and unit disposal costs are sensitive to facility capacity. Generators with small volumes of waste requiring rotary kiln incineration (less than 5,000-10,000 MT) would generally find it to their economic advantage to dispose of such wastes off site.

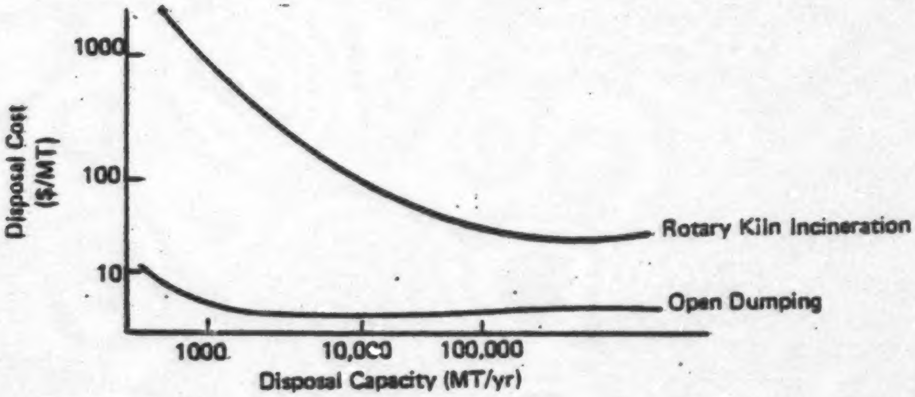
The estimated sizes of typical facilities were based on Arthur D. Little, Inc.'s general knowledge of the industry as well as on information from the literature and telephone interviews. Secure landfills with capacities ranging from 30,000 to 150,000 MT/yr are operated by national companies such as Waste Management, Inc., SCA Services, Inc., and Browning Ferris Industries. Sanitary landfills range in capacity from less than 20,000 to more than 100,000 MT/yr and are operated by both municipalities and waste disposal companies. Dumps vary greatly in size depending on the nature of their operations. Mineral beneficiation dumps have capacities exceeding 1,000,000 MT/yr. Dumps for general refuse (such as municipal solid waste) can handle over 100,000 MT/yr but are now being closed because of the elimination of open dumping and the implementation of new state and Federal regulations such as RCRA.

Off-site incinerators range in size from 50 million to 120 million Btu/hour heat input. For example, Rollins Environmental Services, Inc., has three units of about 100 million Btu/hour each, and SCA has a 75-million and a 120-million Btu/hour unit. Assuming a waste with a heating value of 90,000 Btu/gal, a density of 10 lb/gal, and 260 days of operation/year, a 100-million Btu/hour unit has an annual capacity of 7 million gallons (31,500 MT). Capacity to burn wastes depends upon the waste's physical and chemical characteristics and its heating value.



Source: Arthur D. Little, Inc.

FIGURE C-2. RELATIONSHIP OF COST AND CAPACITY IN OFF-SITE DISPOSAL



Source: Arthur D. Little, Inc.

FIGURE C-3 COST/CAPACITY RELATIONSHIPS FOR ALTERNATIVE DISPOSAL METHODS

Table C-1 shows the capacities assumed for each disposal facility in the cost analysis. In general, the capacities are sufficiently large that a further increase would not sharply reduce the disposal cost per ton.

TABLE C-1

CAPACITY OF OFF-SITE DISPOSAL FACILITIES

Disposal Technology	Capacity (MT/yr)
Land Treatment	50,000
Dump	100,000
Sanitary Landfill	80,000
Secure Landfill	50,000
Drummed Waste in Secure Landfill	50,000
Halogenated Waste Incineration[a]	10,000
Hydrocarbon Waste Incineration	20,000
Rotary Kiln Incineration	20,000

a. SO_2 scrubber used

Source: Arthur D. Little, Inc., estimates based on current disposal industry practices and economies of scale.

Incremental compliance costs were developed for each off-site disposal facility. Table C-2 displays these costs including plant overhead but excluding the testing costs, corporate overhead, and profit.

Table C-2 shows costs per disposal plant that can be directly translated into costs per ton disposed. The costs for testing are related to shipments to the plant rather than to the plant itself; for this reason, the testing costs and prices are treated separately at the end of this appendix.

The disposal price change was estimated by projecting the ISS compliance costs over 20 years and calculating the price change required to cover these costs, changes in corporate overhead, and the cost of capital. To estimate the overhead changes, a *pro forma* income statement and a balance sheet for a waste disposal company were constructed. The cost-of-capital value discussed in Appendix E was used to keep the return on equity constant after the cost change. Table C-3 contains the 1978 income statements for Waste Management, Inc., SCA Services, Inc., and Browning Ferris Industries; their balance sheets are shown in Table C-4. Ratios among certain income statement and balance sheet items (see Table C-5) were used to define a set of assumed ratios (see Table C-6) for the representative financial statement used as a basis for this analysis. Table C-7 shows the consolidated financial statements constructed by using these ratios. The three firms used as the basis for constructing

TABLE C-2

INCREMENTAL ISS COMPLIANCE COSTS (EXCLUDING TESTING) PER PLANT FOR OFF-SITE DISPOSAL FACILITIES
(000 $)

Disposal Technology (capacity (MT/yr)	Monitoring	Recordkeeping & Reporting[a]	Administration[b]	Training	Contingency	Closure & Post-Closure Fund		Treatment & Disposal	Total
						Tax Deductible	Non-Deductible		
Land Treatment (50,000)									
Capital	23.0	–	–	–	173	–	–	94.7	290.7
Initial	1.8	1.91	12.44	10.18	1.36	–	–	–	27.69
Annual	36.48	2.86	.76	4.5	–	–	–	–	44.6
Closure	–	–	–	–	–	–	1,119	–	1,119
Dump (100,000)									
Capital	23.0	–	–	–	33.3	–	–	16.0	72.3
Initial	2.86	1.91	12.44	10.18	1.36	–	–	–	28.73
Annual	3.3	3.06	.76	4.5	–	–	–	202	213.62
Closure	–	–	–	–	–	–	1,250	–	1,250
Sanitary Landfill (80,000)									
Capital	23.0	–	–	–	31.7	–	–	15.1	69.8
Initial	2.86	1.91	12.44	10.18	1.36	–	–	–	28.73
Annual	3.3	2.86	.76	4.5	–	–	–	177	188.42
Closure	–	–	–	–	–	–	1,100	–	1,100
Secure Landfill (60,000)									
Capital	23.0	–	–	–	28.6	–	–	13.4	65
Initial	2.86	1.91	12.44	10.18	1.36	–	–	–	28.73
Annual	3.3	2.66	.76	4.5	–	–	–	134	145.22
Closure	–	–	–	–	–	–	867	–	867
Halogenated Waste Incineration (10,000)									
Capital	–	–	–	–	10	–	–	–	10
Initial	1.8	1.91	12.44	10.18	1.36	–	–	–	27.69
Annual	11.0	3.23	.76	4.5	–	–	–	–	19.49
Closure	–	–	–	–	–	–	567	–	567
Hydrocarbon Waste Incineration (20,000)									
Capital	–	–	–	–	10	–	–	–	10
Initial	1.8	1.91	12.44	10.18	1.36	–	–	–	27.69
Annual	11.0	3.23	.76	4.5	–	–	–	–	19.49
Closure	–	–	–	–	–	–	290	–	290

TABLE C-2 (Continued)

Disposal Technology (capacity (MT/yr))	Monitoring	Recordkeeping & Reporting[a]	Administration[b]	Training	Contingency	Closure & Post-Closure Fund		Treatment & Disposal	Total
						Tax Deductible	Non-Deductible		
Rotary Kiln Incineration (20,000)									
Capital	–	–	–	–	10	–	–	–	10
Initial	1.8	1.91	11.44	10.18	1.35	–	–	–	26.68
Annual	11.0	3.23	.76	4.5	–	–	–	–	19.49
Closure	–	–	–	–	–	–	1,999	–	1,999

a. $1000 is added to the on-site annual recordkeeping cost for off-site facilities.
b. $3000 is added to the on-site initial administration cost for the higher cost of an off-site permit.

Source: Arthur D. Little, Inc., estimates.

TABLE C-3

INCOME STATEMENTS FOR THREE LARGE WASTE MANAGEMENT FIRMS
(million $)

	1978	1977
Waste Management Inc.		
Revenues	307.1	230.3
Costs & Expenses		
— operating	174.4 (56.7%)	127.5 (55.4%)
— selling & administration	46.1 (15.0%)	35.4 (15.4%)
Depreciation	27.7	22.9
Interest	5.8	6.4
Profit Before Tax	53.1 (17.3%)	35.4 (15.4%)
$\frac{\text{Selling \& Administrative}}{\text{Cost of Operations}}$	0.264	0.278
SCA Services, Inc.		
Revenues	182.5	160.1
Operating, Selling & Administration	146.9 (80%)	129.5 (81%)
Depreciation & Amortization	20.3	19.1
Interest	6.0	6.2
Profit Before Tax	9.3 (5.1%)	5.3 (3.3%)
Browning Ferris Industries		
Revenues	362.9	315.4
Cost of Operations	215.2 (59.3%)	188.8 (59.9%)
Selling, General & Administrative	62.3 (17.2%)	55.4 (17.6%)
Depreciation[a]	33.0	29.1
Interest	9.2	9.0
Profit Before Tax	43.2 (11.9%)	33.1 (10.5%)
$\frac{\text{Selling, General \& Administrative}}{\text{Cost of Operations}}$	0.29	0.293

a. Depreciation attributable to the cost of operations

Source: Company Annual Reports

TABLE C-4

1978 BALANCE SHEETS FOR THREE LARGE WASTE MANAGEMENT FIRMS
(million $)

Assets		Liabilities	
Waste Management, Inc.			
Current Assets	92.4	Current Liabilities	61.0
Plant & Equipment	208.1	Deferred	50.4
Other	43.9	Long Term Debt	70.4
Total	344.4	Equity	162.6
		Total	344.4
SCA Services, Inc.			
Current Assets	35.6	Current Liabilities	29.6
Plant & Equipment	99.5	Deferred	9.6
Other	31.0	Long Term Deby	60.0
Total	166.0	Equity	66.8
		Total	166.0
Browning Ferris Industries			
Current Assets	80.6	Current Liabilities	$ 55.5
Plant & Equipment	226.8	Deferred	26.5
Other	58.4	Long Term Debt	106.7
Total	365.8	Equity	177.0
		Total	365.8

Source: Company Annual Reports

the financial tables are the largest in the waste management business. They are financially stronger than the small, one-plant companies, but they may also have higher overhead costs. Their implied price changes may be somewhat higher than those for a very small operation where profit and operator salary are not clearly differentiated.

The annual and initial compliance costs were increased by 28% to allow for corporate overhead expenses. The new operating practices under the ISS are similar in nature to those currently in use in the waste disposal business and the effect of the higher costs will be to increase the scale of the business. The risks associated with the new expense may be greater than those for the current business and will certainly not be lower. For these reasons, the incremental costs of compliance with the ISS will result in higher corporate overhead expenses. These expenses will be reflected in the new price charged for the disposal service.

The incremental expenses also require additional capital investment in the business for working capital. The new working capital requirements are 7.8% of the total change in annual expenses, including overhead. The new working capital requirement is 10% of incremental ISS expenses during the year, excluding overhead.

TABLE C-5

SELECTED INCOME STATEMENT AND BALANCE SHEET RATIOS

	Current Assets/ Current Liabilities	Current Assets/ Total Assets	Cost of Operations + General & Administrative + Interest/Current Assets	Revenues/ Total Assets	Equity/ Total Assets	Profit Before Taxes/ Equity	Long Term Debt/ Total Assets
Waste Management, Inc.	1.51	0.268	2.45	0.892	0.472	0.327	0.20
SCA Services, Inc.	1.20	0.215	4.29	1.10	0.402	0.139	0.36
Browning Ferris Industries	1.46	0.22	3.58	0.992	0.484	0.244	0.29
Typical	1.46	0.23	3.4	1.0	0.47	0.30	0.28

Source: Computed by Arthur D. Little, Inc., from Company Annual Reports

TABLE C-6

ASSUMPTIONS FOR REPRESENTATIVE WASTE MANAGEMENT FIRM INCOME STATEMENT AND BALANCE SHEET

$$\frac{\text{General and Administrative}}{\text{Cost of Operations}} = 0.28 \qquad \frac{\text{Depreciation}}{\text{Plant \& Equipment}} = 0.15$$

$$\frac{\text{Cost of Operations}}{\text{Revenue}} = 0.58 \qquad \frac{\text{Equity}}{\text{Total Assets}} = 0.47$$

$$\frac{\text{Long Term Debt}}{\text{Total Assets}} = 0.28 \qquad \frac{\text{Current Assets}}{\text{Current Liabilities}} = 1.45$$

$$\frac{\text{Plant \& Equipment}}{\text{Total Assets}} = 0.60 \qquad \frac{\text{Cost of Operations + General \& Administrative + Interest}}{\text{Current Assets}} = 3.4$$

Source: Computed by Arthur D. Little, Inc., from Company Annual Reports.

TABLE C-7

PRO FORMA FINANCIAL STATEMENTS FOR A REPRESENTATIVE HAZARDOUS WASTE MANAGEMENT COMPANY

Income Statement

Revenues	$1000
Cost of Operations	580
General & Administrative	162
Depreciation	90
Interest	27
Profit Before Taxes	141

Balance Sheet

Assets		Liabilities	
Current Assets	$ 230	Current Liabilities	$ 172
Plant & Equipment	600	Deferred	58
Other	170	Long Term Liabilities	300
Total	$1000	Equity	470
		Total	$1000

Source: Arthur D. Little, Inc. estimates.

Price projections in this analysis were made separately for the disposal costs and the testing costs separately because disposal expenditures are uneven from year to year. The disposal costs were projected over 20 years, using an inflation rate of 10%/year for years 1 through 5 and 7%/year for years 6 through 20 (see Appendix D for further discussion of inflation rates). The yearly revenues for the facility were derived with two constraints: the present value of the revenue stream will equal the present value of the required cash outlays; and the revenue per ton will increase at the inflation rate. The computation was performed by a computer program executing the following calculations:

$$\text{Price Per MT (In Year 1)} = \frac{\sum_{i=1}^{i=n} [OP_i(1-T_i) + I_i(1-T_i) - D_iT_i + C_i + P_i] \div (1+k)^i}{\sum_{i=1}^{i=n} INF_i \, X \, V_i(1-T_i) \div (1+k)^i}$$

where:
i = year of operation
n = number of years of operation
OP_i = operating expenses in year i (initial cost + operating expenses, plus corporate overhead)
T_i = tax rate divided by 100 in year i
I_i = interest paid on the loan(s) in year i
D_i = depreciation in year i
C_i = equity, plus/minus increase/decrease in working capital in year i, and for the last year the scrap value of the investment, plus the accumulated working capital as a cash inflow
P_i = principal repayment of the loan(s) in year i
INF_i = inflation factor in year i
V_i = volume in year i
k = cost of capital

(The model assumes that if a tax credit occurs in any given year, the company will benefit from it in that year against other profitable operations. Therefore, tax credits are not carried forward.)

The unit incremental price per MT of waste was calculated for the first year (Table C-8) for each disposal technology at the designated capacity. The incremental prices for land disposal technologies range from $6.74 to $9.33/MT, excluding testing costs. Prices for incineration of hydrocarbon wastes (HC) will increase by $5.74/MT and price increases for halogenated wastes will be $18.30/MT.

Testing costs per MT are a function of the tons an individual generator sends to the disposal facility rather than the capacity of the facility itself. Appendix B

TABLE C-8

INCREMENTAL PRICE FOR OFF-SITE WASTE DISPOSAL RESULTING FROM RCRA ISS (EXCLUDING TESTING)

(1978 $)

Disposal Technology	Price ($/MT)	Formula Code[a]
Land Treatment	8.79	TR-10 and I-TR-10
Sanitary Landfill	7.45	TR-4 and I-TR-4
Secure Landfill	9.33	TR-7 and I-TR-7
Drummed Waste in Secure Landfill	9.33	TR-8 and I-TR-8
Halogenated Waste Incineration	18.32	TR-5 and I-TR-5
Hydrocarbon Waste Incineration	5.74	TR-6 and I-TR-6
Rotary Kiln Incineration	27.27	

a. Code refers to notation in computer program (See Table V-1 in Chapter V).

Source: Arthur D. Little, Inc., estimates.

describes the testing costs applicable to waste shipments to a commercial disposal operation. The costs are annual expenses, increasing with the inflation rate. These costs were translated into prices by adding to the cost of testing the 28% overhead value and the cost to the firm of the incremental working capital. As noted earlier, the incremental working capital required by the higher testing cost is 10% of the testing cost, and the cost of capital in year 1 is 18.5%. The price of testing charged to the waste generator is 1.2985 times the cost of the testing. Table C-9 lists the costs and prices of testing for various-sized generators.

For most generators using commercial disposal facilities, the added cost of testing attributable to the ISS will be about equal to the combined incremental cost of all other compliance activities at the facility. The testing cost per MT rises rapidly below 80 MT/year because the generator will be charged a minimum fixed fee of $777/year, regardless of the quantity of waste shipped, assuming four shipments during the year. At 10 MT/year per waste stream, the price of testing charged to the generator will be $77.70/MT. At 10,000 MT/year the price drops to $3.34/MT.

The total price per MT of off-site disposal, excluding transportation, as a function of the yearly waste generation rate is plotted on Figures C-4 and C-5 for the various disposal technologies. These values were used in the analysis as incremental compliance costs to waste generators shipping their waste to off-site disposal facilities.

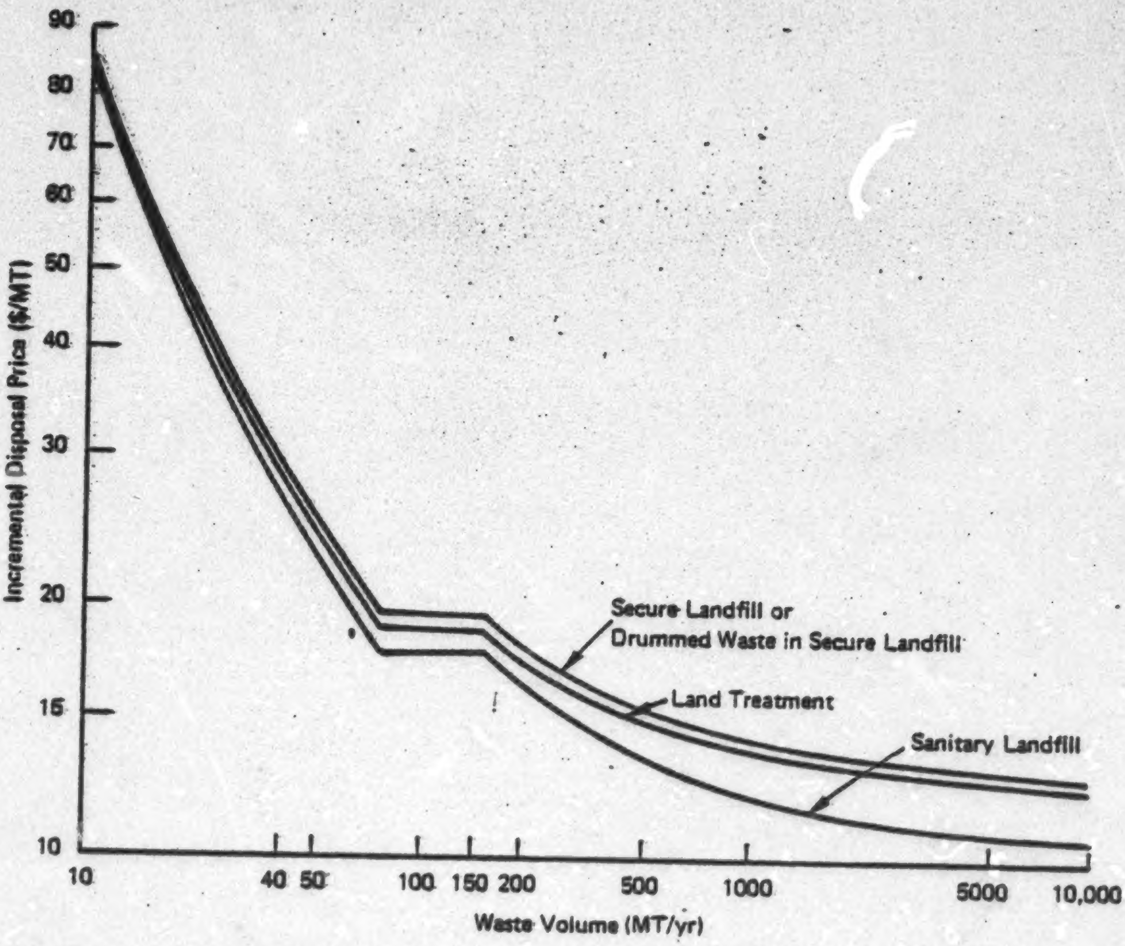
TABLE C-8

COST AND PRICE OF TESTING AT COMMERCIAL DISPOSAL FACILITIES AS A FUNCTION OF GENERATOR WASTE VOLUME

(1978 Dollars)

Tons of Waste per Year per Waste Stream	Cost of Testing	Cost of Testing per Ton of Waste	Total Price to Generator	Price to Generator per Ton
10	$ 600	$60	$ 777	$77.90
40	600	15.0	777	19.48
80	600	7.50	777	9.74
110	825	7.50	1,070	9.74
160	1,200	7.50	1,550	9.74
300	1,550	5.17	2,010	6.71
500	2,050	4.10	2,660	5.32
2,000	5,800	2.90	7,520	3.77
5,000	13,300	2.66	17,200	3.45
10,000	25,800	2.58	33,400	3.35

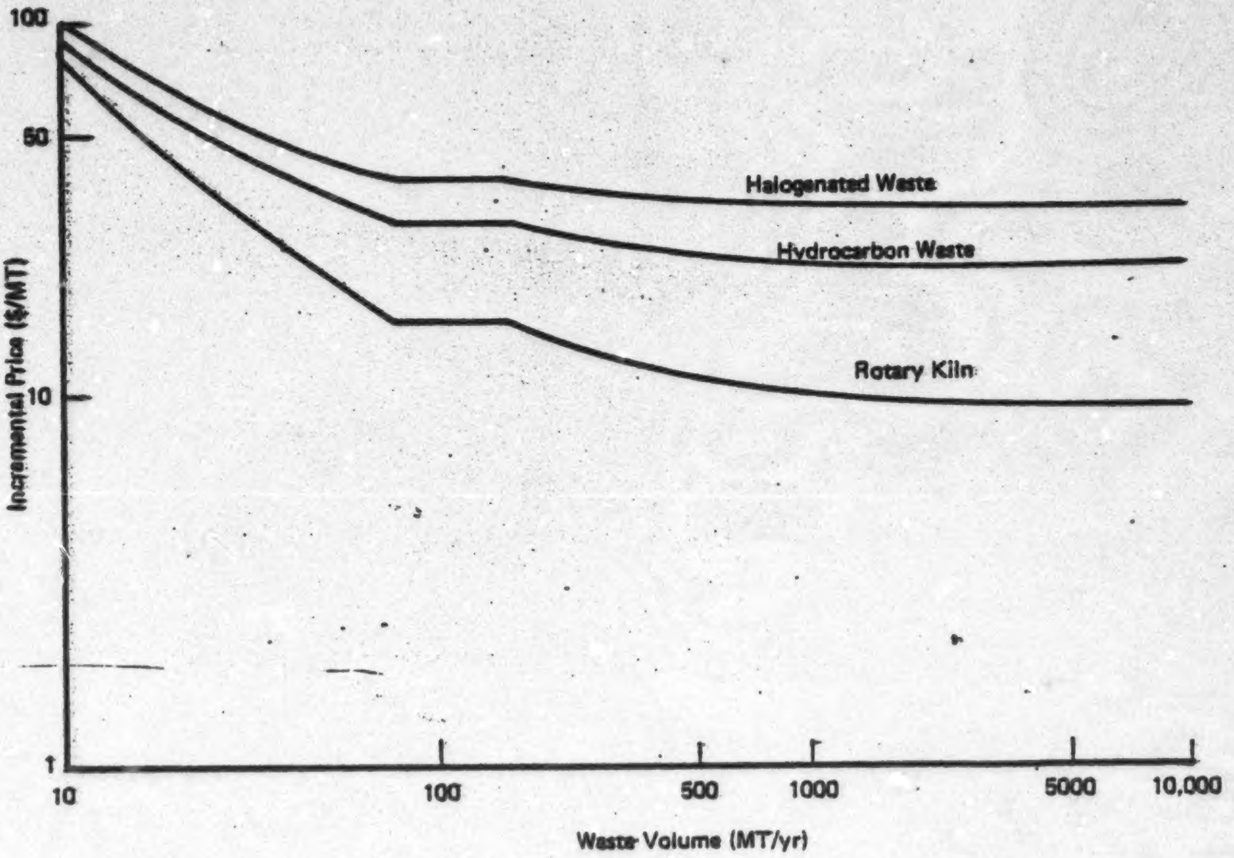
Source: Arthur D. Little, Inc., estimates.



Note: Incremental Price Includes Testing Cost

Source: Arthur D. Little, Inc., estimates

FIGURE C-4 INCREMENTAL PRICE OF DISPOSAL VS. WASTE GENERATION



Note: Incremental Price Includes Testing Cost

Source: Arthur D. Little, Inc., estimates.

FIGURE C-5 INCREMENTAL PRICE OF INCINERATION VS. WASTE GENERATION

APPENDIX D

PROJECTED U.S. INFLATION RATES

APPENDIX D

PROJECTED U.S. INFLATION RATES

The report estimates incremental compliance costs in dollars valued at the end of 1978, although the costs will begin to be incurred in 1980.* The effect of inflation after 1980 is an integral part of the cost of compliance analysis. For example, the "incremental annual compliance cost" is computed by projecting the incremental costs over the first 20 years of the ISS program, taking the present value of the cost stream, and converting this value to an annuity. The price of off-site disposal services and the cost of capital, which is used as the discount rate, also include an inflation factor.

In determining the inflation rate to be used in the analysis the 20-year period covered by this analysis was divided into two parts — the first 5 years and years 6-20. An average yearly inflation rate (based on consumer prices) of 10% was assumed from 1980-1985. This rate is high by historical U.S. standards and higher than the 8% yearly average of the last 5 years, but lower than the rate for 1980 which was 12.4%. The rate used in the cost analysis for the 1986-2000 period was 7% per year.

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*Several unit costs are in 1979 dollars.

APPENDIX E

COST OF CAPITAL

APPENDIX E
COST OF CAPITAL

1. INTRODUCTION

In order to evaluate the present value of the incremental expenditures and revenues at both off-site and on-site hazardous waste facilities that will result from the ISS, it is necessary to determine the appropriate discount rate of firms engaged in the hazardous waste management business. The discount rate corresponds to the firm's marginal cost of capital (the cost of additional funds today) and is a function of the risk associated with the collection of assets that constitute the business entity. The purpose of this appendix is to explain the procedure used to calculate the marginal cost of capital for both small and large firms in the hazardous waste disposal business used in the analysis described in this report.

Calculation of the Weighted Average Cost of Capital (WACC) for the large model firm was based on readily available market data and fundamental financial theory. For the small model firm, the lack of publicly available financial data made it necessary to rely on other types of analysis. The behavior of large and small firms was examined in five industries, and the conclusions were extended to companies engaged in the management of hazardous waste.

The WACC for a publicly traded hazardous waste firm is estimated to be 18.5% and 15.7% for an annual inflation rate of 10% and 7%, respectively. The findings also suggest that these rates are appropriate for application to the small model firm.

2. COST OF CAPITAL CALCULATIONS FOR THE HAZARDOUS WASTE DISPOSAL INDUSTRY

Cost of capital was estimated for two types of firms in the hazardous waste disposal business. The first was a large corporation with publicly traded stock. The second was a "small," privately held firm in the industry.

a. Large Model Firm

For the large firm, the cost of capital was calculated using the weighted average cost of capital, K_W. The cost of equity capital was estimated by the Capital Asset Pricing Model (CAPM), which compares the volatility of a firm's rate of return to that of the stock market as a whole. The cost of debt finance is the average of the yield-to-maturity of the firm's debt issues. Market values were used to determine the weight of debt and equity components on the firm's balance sheet.

The calculations for cost of capital were based on three companies engaged in solid waste collection, storage, processing, and disposal. The selected companies were Waste Management, Inc., SCA Services, Inc., and Browning Ferris Industries. Each company obtains a significant portion of its earnings from hazardous waste management.

To the extent that these companies are engaged in other lines of business, the derived costs of the different capital components do not reflect only the risk associated with hazardous waste processing and disposal operations. Nevertheless, the cost of capital for each company was considered a reasonable approximation of the true capital costs associated with large firms engaged in hazardous waste management.

Balance sheet data of the three companies were adjusted to reflect the market value of equity and debt capital. The market values are based on trading prices and bond yields as of August 31, 1980. The results of the calculations appear in Table E-1.

TABLE E-1

MARKET VALUE OF EQUITY AND DEBT CAPITAL OF THREE HAZARDOUS WASTE FIRMS

($ thousand)

	Waste Management, Inc.	SCA Services, Inc.	Browning Ferris Industries
Short-Term Debt	–	3,040	6,779
Long-Term Debt	73,496	63,085	119,705
Stockholders' Equity	829,306	178,362	353,491
Total	902,802	244,487	479,975

Source: Arthur D. Little, Inc.

The portion of debt and equity for a large model firm was determined by combining the individual capital components of the three selected companies:

Short-Term Debt/Total Capitalization = 0.01
Long-Term Debt/Total Capitalization = 0.16
Stockholders' Equity/Total Capitalization = 0.83
Total Capitalization = Short-Term Debt Plus Long-Term Debt Plus Stockholders' Equity.

The cost of long-term debt for the large model hazardous waste management firm is 12.1%. It was estimated by taking a weighted average of the cost of debt of the individual companies. The cost of short-term debt was 10.5%, the going commercial rate at the end of August 1980.

The cost of equity capital of the large model firm was based on the CAPM. Using betas calculated by Value Line Investment Service, the cost of levered equity capital was estimated for Waste Management, Inc., SCA Services, Inc., and Browning Ferris Industries.

The risk-free Treasury bill rate at the end of August 1980 was 10%, and the historical risk premium, i.e. (R_M-R_F), was 9%.* Taken together, the rate of return required on levered equity is 21.25% for SCA Services, Inc., and Browning Ferris Industries and 20.8% for Waste Management, Inc. The cost of levered equity for the large model firm, determined by taking a weighted average of the return required on levered equity by shareholders of each of the three companies, is 21%. Thus, the implied beta of the large model firm is:

$$E(R_E^L) = R_F + \beta_E^L\,[E(R_M) - R_F]$$

$$21.0 = 10.0 + \beta_E^L\,(9)$$

$$\beta_E^L = (21 - 10) \div 9 = 1.22$$

where: $E(R_e^L)$ = expected rate of return on the firm's levered equity

R_F = the risk-free, single-period rate of return

β_E^L = the beta (volatility measure) of the firm's levered equity

$E(R_M)$ = expected rate of return on the market portfolio

The required rate of return on the equity of an unlevered firm (pure equity), calculated using the adjustment formula

$$\beta_e^L = \beta_e\,[1 + (1\text{-}t)\frac{D}{E}] - (1\text{-}t)\,\beta_D\,\frac{D}{E}$$

to first determine the beta of the all-equity firm, is 21%.

Combining the cost of debt after tax with the leveraged cost of equity yields the weighted average cost of capital (WACC) of the large model hazardous waste management firm.

$$\begin{aligned}\text{WACC (after-tax)} &= W_E R_E + W_S R_S\,(1-t) + W_D R_D\,(1-t)\\ &= (0.83)(21.0) + (0.01)(10.5)(1-0.46) + (0.16)(12.1)(1-0.46)\\ &= 17.43 + 0.06 + 1.05\\ &= 18.5\%.\end{aligned}$$

where: W_E = the percent of equity in the firm's capital structure

R_E = the required rate of return on the unlevered firm's equity

R_S = the required rate of return on the firm's short-term debt

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*Ibbotson, R.G. and R.A. Sinquefield. *Stocks, Bonds, Bills, and Inflation: The Past (1926-1976) and the Future (1977-2000)*. Financial Analysts Research Foundation, University of Virginia, Charlottesville, VA., 1977.

R_D = the required rate of return on the firm's long-term debt

W_S = the percent of short-term debt in the firm's capital structure

W_D = the percent of long-term debt in the firm's capital structure

t = corporate tax rate = 0.46

b. Effect of Inflation on the Weighted Average Cost of Capital

As short-term and long-term expectations about inflation vary so does the firm's cost of capital. The inflationary expectations held by the providers of capital are embodied in their required rates of return. The real return on risk-free government securities has been very close to 0%. This means that the return on Treasury bills approximates the rate of inflation, and the real cost of equity and debt capital can be determined by subtracting the T-bill rate from the calculated required rates of return.

The after-tax cost of capital calculated above embodies an annual inflation rate of 10%, given by the T-bill rate on August 31, 1980.* On the other hand, the after-tax cost of capital if the expected annual inflation rate is 7% can be determined by adjusting the required rates of return on each of the capital components (Table E-2).

TABLE E-2

AFTER-TAX COST OF CAPITAL ACCOUNTING FOR INFLATION

	Real Rate of Return (no inflation)	Rate of Return (7% inflation)
Short-Term Debt	10.5 – 10.0 = 0.5%	0.5 + 7.0 = 7.5%
Long-Term Debt	12.1 – 10.0 = 2.1%	2.1 + 7.0 = 9.1%
Shareholders' Equity	21.0 – 10.0 = 11.0%	11.0 + 7.0 = 18.0%

Source: Arthur D. Little, Inc.

Thus,

$$\begin{aligned} \text{WACC (After-Tax)} &= (0.83)(18.0) + (0.01)(7.5)(0.54) + (0.16)(9.1)(0.54) \\ &= 14.94 + 0.04 + 0.79 \\ &= 15.7\%. \end{aligned}$$

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*GNP deflator.

The average ratio of the unlevered beta of the small firm to the large firm and the equivalent ratio for the return on long-term debt were calculated. A value very different from 1.0 would indicate systematic variation in required rates of return attributable to company size. A value close to 1.0 may be interpreted as meaning that required rates of return do not differ significantly with firm size.

The calculated values were:

$$1/5 \sum_{i=1}^{5} \frac{\beta_{e,S}}{\beta_{e,L}} = .91$$

$\beta_{e,S}$ = unlevered beta of the small firm

$\beta_{e,L}$ = unlevered beta of the large firm

and

$$1/5 \sum_{i=1}^{5} \frac{K_{D,S}}{K_{D,L}} = 1.14$$

$K_{D,S}$ = the cost of long-term debt of the small firm

$K_{D,L}$ = the cost of long-term debt of the large firm

The pure equity rate of return appears to be slightly lower for the smaller companies. On the other hand, small companies appear to pay a premium on debt capital. Neither ratio, however, is statistically different from 1.0 in view of the sample size. Thus, based on the present analysis, the cost of debt and equity capital for the small and large hazardous waste firms are approximately the same. If both types of firms employ the same portion of debt and equity in their capital structure, then the weighted average cost of capital calculated for the large model firm is the appropriate discount rate for the small model hazardous waste firm.

Two factors have an important effect on the conclusions reached in this analysis. The first is sample size. A small sample size may not reveal the relationships that actually exist in the financial characteristics of small and large firms. Since the objective was to base results on real data, the small firms, though small in relation to the selected large companies, may, in fact, be large with respect to other privately held hazardous waste management firms. If the relationship between size and capital costs is not linear, then the conclusions based on the selected companies may not apply to companies much smaller on an absolute scale.

c. Small Model Firm

Most small firms in the hazardous waste industry are privately held and are not subject to SEC reporting requirements. As a result, access to their financial information is limited, and their debt and equity securities are not publicly traded.

In order to determine the cost of capital for the small model firm, five industries were analyzed. For each industry, a "small" and "large" company were selected according to such criteria as total assets, annual sales, and availability of market data. Value Line betas were used to determine the cost of levered equity capital for the companies examined. The market value of debt and equity capital was calculated in the same way as for the large model hazardous waste firm. In the case of small companies whose debt instruments are not publicly traded, Standard and Poor ratings of overall company performance were used as a proxy for bond quality ratings. The internal rate of return for traded bonds of similar quality and time to maturity was used to adjust the book value of debt and to estimate the cost of debt capital. This approach assumed that the overall company rating is correlated with the individual quality ratings of the firm's debt issues. Since all the selected companies were publicly held, the trading price of their common stock was readily available as of August 31, 1980. Therefore, the market value of shareholders' equity simply equaled the security price times the number of shares outstanding. The unlevered betas were calculated in order to standardize firms with different capital structures, making possible inter-company comparisons of the pure equity required rate of return.

The results for each of the five industries are shown in Table E-3.

TABLE E-3

UNLEVERED BETA AND REQUIRED RETURN ON LONG-TERM DEBT FOR FIVE INDUSTRY SECTORS

		Health Care/ Hospital Supplies	Agricultural Equipment	Household Products	Drugs, Ethical	Paper and Forest Products
Large	β_e[a]	1.08	0.66	0.78	0.97	1.01
	K_D[b]	10.75	12.22	10.38	10.55	11.68
Small	β_e	0.8	0.52	0.87	1.05	0.81
	K_D	12.54	14.23	12.51	11.40	12.55

a. β_e = the unlevered beta

b. K_D = required return on long-term debt

Source: Arthur D. Little, Inc.

APPENDIX F

ECONOMIC CHARACTERIZATION AND IMPACT ON SELECTED GENERATOR INDUSTRIES

APPENDIX F

ECONOMIC CHARACTERIZATION AND IMPACT ON SELECTED GENERATOR INDUSTRIES

1. INTRODUCTION

This appendix characterizes each of the 22 generator industries in terms of structure, supply and demand balance, profitability, and capital expenditures. The appendix also presents a qualitative assessment of the cost of complying with the Interim Status Standards (ISS) for each industry as well as of economic impacts in terms of potential price increases, plant closures, job losses, production cutbacks, and balance of payments effects.

The chance of occurrence of a given impact, e.g., plant closures, has been classified as either likely, probable, possible, unlikely, negligible, or none (see Table F-1). "Likely" means a chance of more than 75% that some plants in an industry segment will close because of the added cost of the regulations. "Probable" means a 51-75% chance; "possible" means a chance of 26-50%; "unlikely" means a chance of 11-25%; "negligible" means a chance of 0.5-10%; and "none" means no plant closures are expected.

TABLE F-1

DESCRIPTORS OF ECONOMIC IMPACTS USED IN THE QUALITATIVE IMPACT ASSESSMENT

% Probability of Change in Impact Measure	% Change in Impact Measure	
	0-0.5	0.5 and Above
0.0	none	none
0-10	negligible	negligible
11-25	negligible	unlikely
26-50	negligible	possible
51-75	negligible	probable
76-100	negligible	likely

Source: Arthur D. Little, Inc.

Only changes in the impact parameters greater than 0.5% are considered as economic impacts. For example, even a highly probable production curtailment of 0.1%, is classified as "negligible." A 60% chance of a 1% production curtailment, however, ranks as "probable." Thus, the impact assessment measures only non-trivial changes.

The impact assessment is carried out for each of the economic impact criteria, i.e., price increases, plant closures, job losses, production cutbacks, and balance of payments effects. The following sections describe and tabulate the results of this assessment for each of the 22 industries.

2. THE AGRICULTURAL SERVICES INDUSTRY (SIC 0711, 0721, 0729)

a. Characterization of the Agricultural Services Industry

(1) Industry Description

The agricultural services industry provides services for soil preparation, crop planting, and/or crop protection. Potentially hazardous wastes are generated primarily from pesticides applied to farm land. Firms that apply such materials (as well as fertilizers) are generally called "custom applicators." Custom applicators treat approximately one-third of the acreage receiving pesticide applications in the United States. Farmers themselves treat the remaining two-thirds.*

Firms that apply pesticides are quite diverse in size, product, service lines, and organization. They range from a farmer who may apply pesticides for a neighbor (assumed to be exempt under the current interpretation of RCRA) to a firm that treats more than 100,000 acres. Both ground equipment and airplanes are used; most aerial applicators tend to concentrate on custom application as their single line of business. Some, however, may sell a portion of the chemicals they apply, and others may use their aircraft for other commercial purposes. For ground applicators, the situation is reversed; most tend to provide multiple services to the farmer, e.g., fertilizer application, soil preparation, etc. as well as pesticide treatment. Custom applicators may be owner-operated, part of a cooperative's services, a corporation, or a division or subsidiary of a corporation. Because many custom applicators operate at two or more sites, the industry may generate hazardous wastes at more than 22,00 locations.

Firms tend to vary in the type of equipment they use and the type of pesticides they apply, depending on the dominant cropping patterns of each state or substate district. State regulations governing the use of pesticides, the toxicity of the compounds, and the organizational structure and size of farms frequently influence the number and size of custom applicators and the acreage they treat compared with farmers. In the Pacific states, for example, where farms are often large and in many cases owned by corporations, highly toxic insecticides are often employed, and pesticide regulations are more stringent, custom applicators treat 60% of the acreage. In the Corn Belt, on the other hand, where farms are generally owner-operated, less toxic herbicides are used, and state pesticide regulations are not stringent, custom applicators treat only 22% of the acreage.*

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*Eichers, Theodore R., *Farmers' Use of Pesticides in 1976*, U.S. Department of Agriculture, Economic Research Service #418, December 1978.

(2) Segmentation

Possible sources of hazardous waste are empty containers, unused pesticides, and wastewater (from rinsing or washing containers and equipment). Although some pesticides, residues, and empty containers may not qualify as hazardous wastes, it was not possible to analyze the nature of products applied on a firm-by-firm basis, and this study assumes that all custom pesticide applicators are subject to RCRA.

(3) Structure

Investment entry costs are relatively small, since some ground equipment can often be used for tasks other than pesticide application, and the type of service required can vary tremendously, e.g., by location, crop type, compounds, and field size. The four-firm concentration is therefore extremely low (see Table F-2), with the largest firm controlling less than 0.1% of the national market. Within a region, however, one or only a few firms may control the entire custom application market. Nevertheless, because of ease of entry and the fact that farmers can in most cases apply pesticides themselves, local concentration does not lead to monopolistic pricing practices.

(4) Supply and Demand

In 1978, sales for the custom application industry were approximately $1.2 billion for services, excluding any related pesticide sales.* Historically, the industry has grown rapidly, with dollar volume of sales quadrupling and acres treated doubling since 1972. This rapid growth is the result of increased use and regulation of pesticides, rising prices, increased specialization, and expanded crop plantings. Over the next 5 years growth will continue, but at a slower rate, about 10% annually. This slowdown will be attributed to less expansion in U.S. crop acreage, selected adoption of integrated pest management (IPM) practices, market saturation for many pesticides, and market saturation for some custom application services in some areas.

In some regions of the United States, sales may actually decline for a particular year, or even for a 4-6 year period. If most custom application is for a particular crop, market demand for that crop falls, and crop acreage is subsequently cut back, demand for custom application services would decline.

The potential for substitution for custom pesticide application services could range from low to very high, depending on the region of the country. In most instances, however, the range will be from moderate to high since farmers can generally apply pesticides themselves if they so choose. Potential product substitution, e.g., other control measures in lieu of pesticides, as a result of changes in the custom application industry is insignificant. Since the industry is service-locale oriented, imports do not pose a threat.

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*Arthur D. Little, Inc., estimate based on industry publications, trade information, Agricultural Extension Service crop reports, and U.S. Department of Agriculture studies.

TABLE F-2

ECONOMIC CHARACTERIZATION OF THE AGRICULTURAL SERVICES INDUSTRY (CUSTOM APPLICATORS)

Industry Segment	1978 Production Value ($ Million)	1978 Acres Treated (Millions)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Custom Applicators (SIC 0711,0721, 0729)	1,200 100[a]	300	80[b]	16,500	22,700	< 1	10	low-moderate	moderate-high	none

a. Value added as a percent of production value.

b. Considerably less if days per year of use is used as basis since much equipment is used seasonally and for limited times during a season.

Source: Arthur D. Little, Inc., estimates, based on industry information and trade publications, Agricultural Extension Service crop reports, and U.S. Department of Agriculture studies.

(5) Profitability

No reliable statistics exist for industry profitability or return on equity. One study estimates after-tax profits as approximately 4% of sales (Table F-3).* This profit margin should improve as firms grow larger and capitalize on economies of scale.

(6) Capital Investment

Long-term capital investment plays little role in the custom pesticide application industry. Most investment expenditures are for machinery and equipment, e.g., aircraft, tractors, and spray equipment depreciated over a relatively short time. Investments in such machinery and equipment are generally in response to perceived existing demand or in conjunction with other nonpesticide-related uses. Thus, unacceptable excess capacity seldom exists for any extended period, and unexpected increases in demand for services can quickly be met through purchases of additional machinery and equipment, which is generally readily available.

b. Economic Impact on the Agricultural Services Industry

(1) Cost of Compliance

Table F-4 shows the estimated incremental annual cost of compliance with the ISS for the agricultural services industry. The total first-year expenditure is expected to be about $200 million. The industry is composed of 22,700 small- to medium-sized plants. The total annual cost per plant in the first year will average $8800. The annual cost as a percent of value added will be almost 12% for the average plant. Medium-sized plants will bear a cost of around 2% of value added, while small plants could incur costs of about 20% of value added.

(2) Economic Impact

Given the high costs that small custom applicators will incur, plant closures are considered likely, i.e., the chance of a closure is greater than 75% (Table F-5). Plants most vulnerable to shutdown are "part-time" custom applicators. Some of these companies could shift to such other agricultural service businesses as plowing or crop monitoring, or to the application of nonhazardous fertilizers. The number of closures may be reduced by the purchase of some of the smaller plants by larger companies.

Even with these developments, which might soften the impact of the regulations, job losses are still considered probable (chance 51-75%). On the other hand, production cutbacks and demand reduction are considered negligible (chance 0.5-10%) because some farmers would apply the pesticides themselves if the services of a custom applicator were no longer available.

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*Energy Resources Co., Inc. "Economic Impact Analysis of Hazardous Waste Management Regulations on Selected Generating Industries." Final Report to U.S. EPA, Office of Solid Waste Management, June 1979.

TABLE F-3

FINANCIAL PROFILE OF THE AGRICULTURAL SERVICES INDUSTRY (CUSTOM APPLICATORS)

(1972-1978)

Total Industry (SIC 0711, 0721, 0729)	1978	1976	1974	1972
Profitability[a]				
Net Income After Taxes/Net Sales (%)	← 4% →			
Revenues[b]				
Value of Services ($ Million)	1200	760	480	280
Value Added/Services (%)	100	100	100	100

Sources:

a. No industry data were available; 4% is based on two "model plants" profiled in the Energy Resources Co., Inc., "Economic Impact Analysis of Hazardous Waste Management Regulations on Selected Generating Industries" Report to Office of Solid Waste Management, U.S. EPA, June 1979. Between 1972 and 1978, net income as a percent of sales is believed to have increased somewhat as firms became larger and gained certain economies of scale.

b. Arthur D. Little, Inc., estimates.

TABLE F-4

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE AGRICULTURAL SERVICES INDUSTRY

Industry Segment	1978 Value Added ($ Million)	Cost of Waste Management at the Generator Plant: First Year: Capital ($ Million)	Cost of Waste Management at the Generator Plant: First Year: One-Time Expenses ($ Million)	Cost of Waste Management at the Generator Plant: Annual: Closure Fund[a] ($ Million)	Cost of Waste Management at the Generator Plant: Annual: Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Agricultural Services (SIC 0711, 0721, 0729)	1,200.00	22.97	113.44	1.24	34.86	29.15	201.66	140.87	11.72

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-5

ECONOMIC IMPACT ON THE AGRICULTURAL SERVICES INDUSTRY (CUSTOM APPLICATORS)

Industry Segment	Number of Existing Plants in 1978[a]	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Custom Applicators (SIC 0711, 0721, 0729)	22,700	likely	probable	negligible	likely	negligible	none

[a] Sites of 16,500 commercial applicators where pesticides are stored and mixed for field application

Source: Arthur D. Little, Inc., estimates.

In an effort to recoup the cost of compliance with the regulations, price increases are likely. The amount of the increase is expected to be only slightly muted by the possibility that some farmers can apply pesticides themselves.

3. THE TEXTILE MANUFACTURING INDUSTRY (SIC 2231, 2251, 2261, 2269, 2272, 2291, 2297, 2299)

a. Characterization of the Textile Manufacturing Industry*

(1) Industry Description

The textile manufacturing industry (textile mill products) is extremely diversified and highly fragmented, supporting about 7000 establishments and about 900,000 employees. This industry converts fibrous raw materials (both synthetic and natural fibers) into fabrics (both woven and knit) and a multitude of other end-use products, e.g., carpets, felts, nonwovens, cordage and twine, etc. Production in 1978 included about 15 billion square yards of woven fabrics, 8 billion square yards of knit fabrics, and 1 billion square yards of carpets. The total value of shipments in this industry in 1978 was $43.9 billion.

The domestic apparel industry consumed about 40% of the annual output of the textile industry in 1978. Other major consuming industries are domestic home furnishings (draperies, carpets, blankets, sheets, towels, etc.) and the furniture and automotive industry (upholstery, fabrics, carpetings, interlinings, etc.). Facilities range from highly integrated mills (integrated from basic fiber processing to apparel and home furnishings production) to small, nonintegrated contract plants (commission finishers) that process goods owned by other plants. Most producers are nonintegrated single-plant, regionally oriented firms, although there has been a trend to greater integration of operations within this industry over the past ten years.

In recent decades, the industry has been concentrating in the Southeast, principally in North and South Carolina, Georgia, and Alabama, and this trend is expected to continue. More than 40% of the textile industry is concentrated in the Southeast with nearly 80% of these plants located on the eastern seaboard. The remaining plants are scattered throughout the United States.

(2) Segmentation

According to the standard SIC classification scheme, the textile industry contains nine SIC industry groups and 30 industries. The SIC system groups establishments according to end products. To assess the impact of hazardous waste management costs, the industry has been broken down into eight functional segments likely to generate or handle hazardous waste: wool scouring, wool finishing, woven fabric finishing, knit fabric finishing, carpet finishing, stock and yarn finishing, nonwoven manufacturing, and felted fabric processing. This segmentation excludes greige mills and dry operations, which account for about 80% of the establishments in the industry. These plants do not produce significant levels of hazardous wastes.

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*Development Planning & Research Associates, Inc.

(3) Structure

Wool scouring is a declining business in the United States and is represented by only 17 plants (Table F-6). These plants scour natural impurities from raw wool and other animal raw fibers to prepare the wool for weaving. Four firms account for 73% of the shipment value. This high concentration is expected to continue even in the absence of hazardous waste management regulations.

Wool finishing is also a declining business in the United States and supports 37 plants. Wool finishing plants primarily finish wool fabric, which may include the following processes: carbonizing, fulling, dyeing, and the application of finishes. Production in 1978 was estimated to be about 100,000 MT. While the number of plants operating in this industry has been sharply reduced since 1972, not all of these plants have closed, but instead have shifted to finishing synthetic and cotton woven fabrics.

Woven fabric finishing in the United States is a mature business that supports about 336 plants. Most of the producers are single-plant finishing operations serving regional customers either on a contract basis or as a commission finisher, i.e., providing only the finishing service for the fabric owner. However, many of the largest operations are integrated mills that not only finish the fabric but also weave it. Woven fabric finishing plants primarily finish fabric, a majority of which is woven by commonly employing the following process: desizing, scouring, bleaching, mercerizing, dyeing, printing, and application of finishes.

Knit fabric finishing in the United States has matured rather recently. It supports about 441 plants of which most are integrated single-plant operations. The segment includes 160 hosiery mills. These plants use many of the same processes that woven finishers use, except these plants finish knit fabric instead of woven fabric.

Carpet finishing in the United States is a growing business, supporting 58 plants. Most of these producers are integrated mills manufacturing carpet on a relatively large scale; many of them are connected with major integrated textile firms. Carpet finishing plants are primarily involved in scouring, bleaching, dyeing, printing, and application of finishes to carpets.

Stock and yarn finishing is a diverse segment that includes not only mills and plants specialized in producing pre-dyed yarn for striped and patterned fabrics, but also many integrated mills that dye yarn as a preliminary process in producing greige or unfinished fabric. The segment currently supports about 218 plants that produced an estimated 525 MT of finished goods in 1978. Stock and yarn finishing utilizes many of the processes previously discussed. The major difference is that stock and yarn plants finish primarily stock, yarn, and thread, and not fabric.

TABLE F-6

ECONOMIC CHARACTERIZATION OF THE TEXTILE MANUFACTURING INDUSTRY[a]

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers[c]	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition	Numbe of Employe (Thousa
Wool Finishing (SIC 2231)	300 36[b]	100	85	NA	37	38	-7	high	moderate	high	22.
Knit Fabric Finishing (SIC 2257, 2258)	6,870 28[b]	800	70	NA	441	20	5	moderate	low-moderate	moderate	162.
Woven Fabric Finishing (SIC 2262, 2221, 2222)	5,240 30[b]	1,400	75	NA	336	48	4	moderate	low-moderate	moderate	142.
Stock & Yarn Finishing (SIC 2269, 2281, 2221, 2222)	1,645 34[b]	525	75	NA	218	24	5	moderate	low	moderate	31.
Carpet Finishing (SIC 2272)	2,315 20[b]	400	75	NA	58	26	3	low-moderate	low-moderate	moderate	28.
Felted Fabric Processing (SIC 2291)	135 42[b]	15	80	NA	19	51	3	moderate	low	low	5.
Nonwoven Manufacturing (SIC 2297)	700 21[b]	250	75	NA	40	43	5	moderate	low	low	12.
Wool Scouring[d] (SIC 2299)	140 47[b]	165	80	NA	17	73	-4	moderate	high	moderate	6.

a. The characteristics depicted represent only those facilities which are believed to generate hazardous wastes and not those of the entire textile industry.

b. Value added as percent of production value.

c. The textile industry is segmented according to a functional categorization. Therefore, the designation of the number of producers in the segments is not appropriate or meaningful since there would be an appreciable duplication among the segments.

d. Includes raw wool (greasy basis) and man-made fibers processed in scouring plants.

Source: Development Planning and Research Associates, Inc. estimates based on information obtained from the U.S. Department of Commerce and information contained in a DPRA Study for the Environmental Protection Agency entitled "Economic Impact Analysis of Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Textile Mills Point Source Category," October 1979.

Nonwoven manufacturing is a fast growing technology within the textile industry. This segment includes 40 plants and accounted for an estimated production in 1978 of 250,000 MT, an increase of about 50% over the 1972 level. Nonwoven plants produce textile products of cotton, wool, and synthetics by mechanical, thermal, and/or adhesive bonding procedures.

Felted fabric processing is one of the smallest segments of the textile industry, supporting 19 plants. Its production has grown during recent years; 1978 production is estimated at 15,000 MT. These plants produce nonwoven textile products by employing filling and felting operations as a means of achieving fiber bonding.

(4) Supply and Demand

In most segments of the textile industry, capacity and supply are more than adequate to meet demand over the next five years (Table F-6). Capacity is quite flexible in this industry and can be expanded and contracted rapidly by increasing or reducing the number of shifts operated or the length of the work week.

Although wool scouring was estimated at 165,000 MT (greasy basis), up from 135,000 MT in 1972, higher prices, as well as significant competition from imported wool, wool fabrics and apparel, and other synthetic fibers, will contribute significantly to a slowing in growth of demand through 1983.

The same factors will result in a somewhat stabilized demand for wool finishing through 1983, although the outlook is fairly positive.

The demand for woven fabrics, knit fabrics, and carpets is expected to increase 3-5%/year through 1983.

The demand elasticity for all of the above segments of the textile industry is moderately high, because there is strong competition from substitute products and imports at the final retail level and consumer shifts are quickly felt throughout the textile industry.

The projected 5-year demand growth for pre-dyed and finished yarn and stock (5%/year) will be slightly above the industry average because this is now the best practical route to striped, patterned, or fancy woven or knit fabric production. Over the long term, competition from high-quality printed fabrics will be felt, but the impact will be primarily to slow growth rather than reverse it.

The demand for felted fabrics is expected to remain relatively stable in the near future while the demand for nonwoven manufactured goods is expected to increase.

(5) Profitability

The textile industry is highly cyclical and marginally profitable (Tables F-7 and F-8). Profit margins, even in good years, rarely average more than 3% after taxes. An acceptable return on equity is achieved only by carrying high debt loads,

TABLE F-7

FINANCIAL PROFILE OF THE TEXTILE MANUFACTURING INDUSTRY
(1972-1978)

Total Industry (SIC 22)	1978	1977	1976	1975	1974	1973	1972
Profitability[a]							
Net Income After Taxes/Net Sales (%)	3.1	2.4	2.4	1.5	2.5	2.8	2.6
Net Income After Taxes/Net Worth (%)	11.5	8.6	8.1	4.2	7.8	9.0	7.5
Revenues[b]							
Value of Shipments ($ Million)	43,888.0	40,823.0	36,389.2	31,063.6	32,892.2	31,072.7	28,071.5
Value Added/Shipments (%)	40.0	42.0	39.8	38.8	40.1	41.9	41.7
New Capital Expenditures ($ Million)	1,371.0	1,235.0	1,087.4	996.7	1,169.9	1,120.9	1,127.5

Sources: Development Planning and Research Associates, Inc. based on:

a. U.S. Federal Trade Commission, Quarterly Financial Report for Manufacturing Mining and Trade Corporations 1972-1978; and

b. U.S. Department of Commerce, Census of Manufactures, 1972; Annual Survey of Manufactures, 1973-1976; and 1979 U.S. Industrial Outlook.

TABLE F-8

FINANCIAL PROFILE OF THE TEXTILE MANUFACTURING INDUSTRY

(1978)

Industry Segment	Allocation of Existing Plants	After-Tax Annual Net Income: Percent of Sales (%)	After-Tax Annual Net Income: Percent of Total Assets (%)	Annual Revenues: Value of Shipments ($Million)	Annual Revenues: Value Added as a Percent of Shipments (%)	Annual Net Capital Expenditures ($Million)
Wool Finishing (SIC 2231)	37	1.3	2.9	657.8	16.4	11.1
Knit Fabric Finishing (SIC 2257,2258)	280	1.9	4.4	6,744.5	28.4	193.2
Woven Fabric Finishing (SIC 2261, 2262, 2221, 2222)	336	1.6	3.0	10,966.6	14.3	236.7
Stock + Yarn Finishing (SIC 2269, 2281, 2221, 2222)	218	1.5	3.0	1,783.1	29.5	45.3
Carpet Finishing (SIC 2272)	58	1.3	3.2	2,804.2	16.5	40.5
Felted Fabric Processing (SIC 2291)	19	1.7	2.8	93.7	60.5	3.4
Nonwoven Manufacturing (SIC 2297)	40	2.7	4.4	635.9	23.1	17.9
Wool Scouring (SIC 2299)	17	0.1	0.0	125.5	52.4	4.5

Source: Development Planning and Research Associates, Inc.

which average about 40-50%. During recession years, such as 1975, the return on equity falls at a faster rate than profitability and forces many small firms into bankruptcy because they cannot obtain additional financing. A moderate to high degree of price elasticity and competition from imported goods keeps prices depressed and the industry profitability low.

(6) Capital Investment

The textile industry is fairly capital-intensive, requiring about one dollar of investment for each dollar of shipment value. Much of the capital investment in this industry is old and largely depreciated. New capital expenditures (Tables F-7 and F-8) are for replacement of productive equipment as well as for nonproductive equipment related to environmental control. Because capital investment in place is largely depreciated and profit margins are typically low, the industry's cash flow position is not strong. This situation, coupled with the existing high levels of long-term debt, makes it very difficult to raise new capital for investment.

b. Economic Impact on the Textile Manufacturing Industry

(1) Cost of Compliance

Table F-9 presents the estimated incremental annual cost of compliance with ISS for the subcategories of the textile manufacturing industry. Total first-year capital expenditures are estimated at just over $15 million or approximately $13,000 per plant. First-year one-time expenditures are approximately 35% of the capital expenditures.

With regard to the total annual cost, the industry is estimated to spend $21 million annually to comply with ISS. This represents approximately 0.44% of the impacted plants' value added.

(2) Economic Impact

The economic impacts of ISS compliance for the textile manufacturing industry are summarized in Table F-10. These impacts were assessed on a model plant basis, utilizing a net present value analysis to determine the models' required price increases, their ability to make price increases necessary to offset ISS expenditures, and the potential financial impacts attributable to ISS expenditures. Other potential impacts, such as plant closures, job losses, production cutbacks, demand reduction, and balance of payments effects were also assessed. The impacts presented reflect industry conditions as of 1978 and do not include compliance costs for proposed BATEA and PSES effluent guidelines.

To comply with the ISS, several disposal/treatment methods would be used by the various plants in the industry. These compliance methods and associated costs vary considerably among plants, depending on the plants' processes, current disposal practices, respective waste volumes, and the characteristics of their wastes. For this analysis, the impacts of each disposal method were considered separately.

TABLE F-9

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE TEXTILE MANUFACTURING INDUSTRY

Industry Segment	1978 Value Added ($ Million)	Cost of Waste Management at the Generator Plant: First Year: Capital ($ Million)	Cost of Waste Management at the Generator Plant: First Year: One-Time Expenses ($ Million)	Cost of Waste Management at the Generator Plant: Annual: Closure Fund[a] ($ Million)	Cost of Waste Management at the Generator Plant: Annual: Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Wool Finishing (SIC 2231)	108.00	0.67	0.50	0.09	0.28	0.19	1.75	1.04	2.40
Knit Fabric Finishing – Simple (SIC 2251)	1,154.16	2.70	0.82	0.40	0.83	0.33	5.11	3.47	0.74
Knit Fabric Finishing – Complex (SIC 2251)	461.67	0.88	0.27	0.13	0.27	0.05	1.65	1.07	0.77
Knit Hosiery (SIC 2251)	307.78	0.50	0.31	0.06	0.28	0.09	1.29	0.98	1.26
Woven Fabric Finishing – Simple (SIC 2261)	471.79	2.01	0.63	0.25	0.84	0.35	4.12	3.09	1.67
Woven Fabric Finishing – Complex (SIC 2261)	603.05	1.43	0.35	0.30	0.37	0.24	2.74	1.99	0.99
Woven Desizing (SIC 2261)	597.38	3.65	0.55	0.58	1.02	0.76	6.61	5.02	1.36
Stock & Yarn Finishing (SIC 2269, 2281, 2221, 2222)	525.29	2.56	1.50	0.34	1.00	0.29	5.71	3.67	1.61
Carpet Finishing (SIC 2272)	463.00	0.74	0.26	0.07	0.31	0.05	1.47	0.98	0.87
Felted Fabric Processing (SIC 2291)	56.70	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.33
Nonwoven Manufacturing (SIC 2297)	147.00	0.00	0.04	0.00	0.01	0.00	0.07	0.04	0.08
Wool Scouring (SIC 2299)	65.80	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06
Total	4,861.60	15.13	5.23	2.21	5.20	2.35	30.51	21.36	0.44

a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Estimates by Arthur D. Little, Inc., based on industry data provided by Development Planning and Research Associates, Inc.

TABLE F-10

ECONOMIC IMPACT ON THE TEXTILE MANUFACTURING INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Wool Finishing (SIC 2231)	37	0	0	0	None	None	None
Knit Fabric Finishing – Simple (SIC 2251)	231	0	0	0	None	None	None
Knit Fabric Finishing – Complex (SIC 2251)	48	0	0	0	None	None	None
Knit Hosiery (SIC 2251)	161	6	1,370	8,244,000	None	None	None
Woven Fabric Finishing – Simple (SIC 2261)	206	10	410	16,164,000	None	None	None
Woven Fabric Finishing – Complex (SIC 2261)	71	0	0	0	None	None	None
Woven Desizing (SIC 2261)	59	0	0	0	None	None	None
Stock & Yarn Finishing (SIC 2269)	218	1	160	4,750,000	None	None	None
Carpet Finishing (SIC 2272)	58	0	0	0	None	None	None
Felted Fabric Processing (SIC 2291)	20	0	0	0	None	None	None
Nonwoven Manufacturing (SIC 2297)	39	0	0	0	None	None	None
Wool Scouring (SIC 2299)	17	0	0	0	None	None	None

Source: Development Planning and Research Associates, Inc., based on incremental costs generated by Arthur D. Little, Inc., December 1980, which were lower than those shown in Table F-9.

The variability in compliance expenditures within the industry, coupled with the strong competitive threat from foreign importers and the existing domestic intra-industry competition, indicates that the U.S. textile industry will not be able to raise prices enough to offset ISS compliance expenditures. Furthermore, the impact analysis suggests that some mills may not choose to continue operation after the imposition of the requirements. While the resulting losses in employment in small communities may affect those areas, such closures are not expected to seriously disrupt the industry as a whole. Lost production could be absorbed by existing mills, and the effect on the national balance of payments would be negligible.

The imposition of the ISS will potentially affect 1,166 textile manufacturing facilities. While the price increases required to offset ISS expenditures ranged from zero to 4.5% in the affected model plants, as mentioned previously, no industry-wide price increases are expected. Assuming no price increases, textile mills' returns, cash flows, and net present values will all be reduced. These financial impacts resulted in the projection that 17 plants may choose to cease operations rather than comply with the ISS. These projected 17 closures consist of 10 woven simple mills, 6 knit hosiery mills and 1 stock and yarn mill. The closure of these mills is expected to result in the displacement of approximately 1,940 employees and just over 29 million pounds of textiles. These impacts are expected to have no significant impacts on the U.S. demand for textiles or the U.S. balance of payments.

4. THE WOOD PRESERVING INDUSTRY (SIC 2491)

a. Characterization of the Wood Preserving Industry

(1) Industry Description

The wood preserving industry treats wood, sawed or planed in other establishments, with creosote or other preservatives to prevent decay and to protect against fire and insects. The industry also includes firms that treat and sell crossties, poles, posts, and pilings.

The wood treating process uses either pressure or nonpressure systems. Nonpressure processors use open tanks containing the preservatives in which the wood is immersed. Pressure processors use either aqueous solutions or oil preservatives. Major products include organically treated utility poles and railroad ties as well as inorganically treated lumber used primarily for construction.

In 1978, the estimated value of wood preserving industry shipments was $1.1 billion (Table F-11). Historically, the industry has grown at a slower rate than the GNP. Over the 1978-1983 period, the industry projects a real growth of approximately 2% annually. After-tax profitability is estimated to average 2% of sales (Table F-12). The industry employs approximately 12,500 people.

(2) Segmentation

According to the U.S. Bureau of the Census, some 350 companies operated about 458 wood preserving plants in the United States in 1978. Of these, 87% were

TABLE F-11

ECONOMIC CHARACTERIZATION OF THE WOOD PRESERVING INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Million Cubic Feet)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Wood Preserving (SIC 2491)	1,100 34[a]	327	70	350	468	35	2	low	low	low

a. Value added as a percent of production value.

Sources: Arthur D. Little, Inc., estimates based on U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977 Preliminary Report.

TABLE F-12

FINANCIAL PROFILE OF THE WOOD PRESERVING INDUSTRY

(1972-1978)

Total Industry (SIC 2419)		1978	1977	1976	1975	1974	1973	1972
Profitability[a]								
Net Income After Taxes/Net Sales (%)	upper quartile			5.0				
	median			2.0				
	lower quartile			0.5				
Revenues[b]								
Value of Shipments ($ Million)		1100.0	950.7	704.3	647.7	761.2	557.4	475.8
Value Added/Shipments (%)		34%	33.9%	32.5%	35.2%	42.9%	33.4%	36.9%
Value Added ($ Million)		374.0	322.3	229.0	228.3	326.3	186.3	175.8
New Capital Expenditures ($ Million)		35.0	30.3	22.3	27.5	28.1	11.6	14.8

Sources:

a. Economic Impact Analysis of Alternative Pollution Control Technologies, Wood Preserving Subcategories of the Timber Products Industry, EPA Office of Water Planning and Standards, Appendix C, 1979.

b. Arthur D. Little, Inc., estimates for 1978 based on U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977 Preliminary Report. Other years from the Census of Manufactures and Annual Survey of Manufactures.

single-plant firms. There are a few larger establishments. The largest, Koppers Company, operates 25 plants, and the other multi-plant firms operate no more than 10 plants each. The four-firm concentration ratio is 35% (Table F-11).

In general, firms located in the South treat mostly southern pine while those in the West treat mostly Douglas fir. The majority (90%) of firms treat with oil-borne organic preservatives. All plants have the potential of generating hazardous waste because the preservatives used are hazardous.

Wood preserving companies vary with respect to their degree of vertical integration and ownership. Some companies treat the wood they harvest, some treat the wood they purchase, and some treat wood owned by others, charging a fee for the service. Ownership of companies is about 22% through publicly held corporations; 69% are privately owned and 9% are proprietorships.

(3) Supply and Demand

The value of industry shipments rose from $475 million in 1972 to an estimated $1.1 billion in 1978, primarily because of price increases, with some small amount of real growth (Table F-12). Industry sources place the growth in demand at 2% per year over the 1978-1983 period. Capacity utilization is moderate to low in the industry as a whole. Existing conditions indicate no significant supply constraints over the near term.

The preserved wood market is largely a commodity market that gives regional advantages to nearby producers because of high transportation costs. Sometimes the availability of a particular wood species can also be a factor. Demand elasticity in the industry varies somewhat among products, but the major factors governing demand are the competition within the industry, the economic climate of user industries, and the cost-effectiveness of substitute products.

The industry has experienced significant cost increases for some of the principal raw materials used, especially chemicals and wood. Producers have generally been able to pass on increased costs in the form of higher selling prices, although margins have narrowed during the 1970s.

(4) Profitability

A survey of the industry indicated that after-tax profitability as a percent of sales averaged 2% in 1976, with an upper quartile average of 5% and a lower quartile average of 0.5% (Table F-12).

(5) Capital Investment

The level of new capital investment more than doubled in the wood preserving industry between 1972 and 1978. Much of the increase is attributable to inflation of the cost of capital goods. Most of the new capital investment was for equipment for materials handling, pollution control, and energy conservation. Very little investment was for new plants.

b. Economic Impact on the Wood Preserving Industry

(1) Cost of Compliance

Table F-13 shows the estimated incremental annual cost of compliance with the ISS. The total incremental costs in the first year are roughly $5.5 million. Capital costs represent about 35% of these costs, averaging roughly $4000 per plant. The small firms with surface impoundments are expected to bear a larger relative cost burden than large firms or firms without surface impoundments. Surface impoundments are used to evaporate wastewater generated during the wood preserving process.

The incremental annual cost of RCRA as a percent of value added is about 1.0% for the industry as a whole. The cost impact varies from more than 4% for small plants with surface impoundments to less than 0.5% for plants without surface impoundments. Plants with surface impoundments account for roughly 10% of the total in the industry.

(2) Economic Impact

Under the ISS, plant closures are considered possible (chance of occurrence 26-50%). Since most plants in the industry serve regional markets, they are expected to try to pass on the cost of RCRA compliance to their customers in the form of price increases (Table F-14). Plants incurring cost increases of 4% of value added may not be able to fully cover this cost increase if they compete directly against a plant that is facing only a 0.5% cost increase. Since there are no large plants that can readily absorb displaced workers, job losses are expected to be affected as much as plant closures. Given the relatively low operating rate in the industry, however, only a negligible impact (chance of occurrence 0.5-10%) on production and demand is expected.

5. THE INORGANIC CHEMICAL INDUSTRY (SIC 2812, 2816, 2819, 28194)

a. Characterization of the Inorganic Chemical Industry

(1) Industry Description

Inorganic chemicals are often produced or derived from metallic or nonmetallic ores or brines, from byproduct gases of basic manufacturing processes, and from atmospheric gases. Many inorganic chemicals are solid, noncombustible, and soluble in water. Inorganics used in the manufacture of other chemicals or nonchemical products are used less as building blocks than as processing aids and often do not appear in the final product.

The inorganic chemical industry is characterized by a smaller number of producers than the organic chemical industry and by a higher concentration of sales among the larger producers. The inorganic segment of the chemical industry,

TABLE F-13

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE WOOD PRESERVING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Wood Preserving (SIC 2491)	374.00	1.96	1.87	0.69	0.66	0.35	5.54	3.73	1.00

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-14

ECONOMIC IMPACT ON THE WOOD PRESERVING INDUSTRY

Industry Segment	Number of Existing Plants In 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Wood Preserving (SIC 2491)	468	possible	possible	negligible	likely	negligible	none

Source: Arthur D. Little, Inc., estimates.

already well established by the end of World War II, did not attract the large number of new entrants that the organic sector did.

Table F-15 shows that in 1978 the inorganic chemical industry shipped products valued at about $13 billion. Historically, sales in the industry have grown faster than the Gross National Product (GNP), but industry sources expect the growth rate to match the GNP through 1983. Between 1972 and 1978, after-tax profitability fluctuated around an average of 5.3% of sales and 14% of net worth. This segment of the chemical industry employs approximately 100,000 people. The structure of the inorganic chemical industry is generally oligopolistic, mainly because of the capital-intensive nature of the business and its attendant economies of scale.

(2) Segmentation

Not all segments of the inorganic chemical industry generate hazardous waste. The segments analyzed in this report do not cover the whole industry, but only those segments that previous analysis* has indicated generate the greatest amounts of hazardous waste, i.e., chlor-alkali (mercury cell and diaphragm cell processes for chlorine and caustic soda production), titanium dioxide, chrome pigments, phosphorus pentasulfide, phosphorus trichloride, sodium chromates, and boric acid. Although these segments probably account for a large percentage of inorganic chemical hazardous waste, further analysis is needed to determine whether these segments account for all the hazardous waste produced by the inorganic chemical industry.

(3) Structure

Relatively few producers manufacture the inorganic chemicals that were analyzed in this report except for chlor-alkalis and chrome pigments. The four-firm concentration ratios for the two more widely produced products are 58% for chlor-alkalis and 75% for chrome pigments. The concentration ratios for the rest of the segments are 88-100%.

(4) Supply and Demand

Through 1983, the growth in unit demand for the products under study, except for phosphorus trichloride, is expected to be less than that for the inorganic chemical industry as a whole. Capacity utilization has been 70% or better, in the segments studied, except for phosphorus pentasulfide and phosphorus trichloride, where operating rates were recently at 60% and 65%, respectively. Existing conditions indicate no significant supply constraints over the near term, with the possible exception of boric acid, which has been operating at a 90% capacity utilization level.

Most of the chemicals face a moderate amount of product substitution and generally have a low-moderate price elasticity of demand. Import competition is expected to become increasingly significant for chrome pigments, titanium dioxide, and boric acid.

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*Versar Inc. "Assessment of Industrial Hazardous Waste Practices, Inorganic Chemicals Industry." Contract Number 68-01-2246 prepared for EPA Office of Solid Waste Management Programs, March 1975.

TABLE F-15

ECONOMIC CHARACTERIZATION OF THE INORGANIC CHEMICAL INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand) Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Chlor-Alkali – Mercury Cells[b] (SIC 2812)	254 55[a]	2,536	77	13	27	58	2	low	low	low
Chlor-Alkali – Diaphragm Cell[b] (SIC 2812)	696 46[a]	6,948		31	40					
Chrome Pigments[b] (SIC 2816)	122 22[a]	57	85	12	12	75	0-1	moderate	moderate	moderate
Titanium Dioxide – Sulfate[b] (SIC 2816)	194 54[a]	198	70	4	4	88	2	low	moderate	moderate-high
Titanium Dioxide – Chloride[b] (SIC 2816)	167 49[a]	163		5	6					
Titanium Dioxide – Chloride Ilmenite[b] (SIC 2816)	291 43[a]	291		1	3					
Sodium Dichromate[b] (SIC 2819)	112 41[a]	160	87	3	3	100	2-3	low	low	low
Boric Acid[c] (SIC 2819)	46 50[a]	175	90	3	4	100	0-1	moderate	moderate	moderate
Phosphorus[c] Pentasulfide (SIC 2819)	48 50[a]	70	60	4	8	100	2	low	moderate	low
Phosphorus[c] Trichloride (SIC 2819)	59 50[a]	90	65	5	7	90	4	moderate	moderate	low

a. Value added as a percent of production value
b. Data supplied by Energy and Environmental Analysis Inc.
c. Arthur D. Little, Inc., estimates, based on Bureau of Census, U.S. Department of Commerce.

(5) Profitability

For the inorganic chemical industry as a whole (data are not available for individual segments), after-tax profitability, both in terms of the return on sales and the return on net worth, has fluctuated with the state of the economy (Table F-16). Although the rate of profit for the average company in the industry is reasonably high, the rates of return on sales and net worth after taxes for companies in the bottom half of the industry are quite low. Companies operating at the lower profitability levels and producing one or more of the chemicals under study are most likely to be adversely affected by the proposed hazardous waste management regulations.

(6) Capital Investment

The annual level of new capital investment in the inorganic chemical industry more than tripled between 1972 and 1977. The data include productive and nonproductive investment.

b. Economic Impact on the Inorganic Chemical Industry

(1) Cost of Compliance

Table F-17 shows the estimated incremental annual cost of compliance with the ISS. This table indicates that the chlor-alkali segments have the largest total annualized costs. This is in part due to the large number of plants (67) in these segments and their high production volume (almost 10 million tons in 1978). The costs average about $180,000 for each diaphragm-cell process plant and about $130,000 for each mercury-cell process plant.

On the other hand, with only four plants producing titanium dioxide via the sulfate process, the average cost of the ISS for these plants could approach $900,000 per plant. Three sodium dichromate producers may incur an ISS cost of $370,000 per plant. The average cost per plant for manufacturers of chrome pigments is expected to be about $80,000, while the average cost for producers of titanium dioxide via the chloride/chloride ilmenite processes is about $290,000 per plant.

Plants producing boric acid are expected to incur a total annual cost of $120,000 or about $30,000 per plant. The annual cost as a percent of value added is expected to be about 0.5%.

Phosphorus pentasulfide plants are expected to incur a total annual cost of $50,000 or about $6000 per plant. The annual cost as a percent of value added is estimated to be about 0.25%.

Phosphorus trichloride producers are expected to incur a negligible total annual cost of $10,000. The burden of RCRA is not expected to fall evenly on all the plants in this segment, however. One plant may incur a cost of $6000, while another is expected to incur a cost of only about $1400.

TABLE F-16

FINANCIAL PROFILE OF THE INORGANIC CHEMICAL INDUSTRY

(1972-1978)

Total Industry (SIC 281)		1978	1977	1976	1975	1974	1973	1972
Profitability[a]								
Net Income After Taxes/Net Sales (%)	upper quartile	8.0	9.1	8.3	8.0	8.7	6.8	6.3
	median	5.0	5.8	5.6	5.0	6.2	5.3	3.8
	lower quartile	3.0	3.3	3.2	1.9	3.4	3.4	1.2
Net Income After Taxes/Net Worth (%)	upper quartile	20	21.1	21.7	25.3	22.0	18.0	14.4
	median	14	13.4	16.4	15.6	16.5	12.3	9.7
	lower quartile	4	3.5	8.8	7.5	11.0	8.2	5.4
Revenues[b]								
Value of Shipments ($ Million)		13,000	12,675.2	11,610.8	9,660.8	8,849.1	6,773.4	6,132.7
Value Added/Shipments (%)		50	50.6	53.1	54.0	53.5	55.1	54.5
New Capital Expenditures ($ Million)		NA	1,027.0	813.2	721.0	669.0	372.6	280.4

Sources: a. Dun and Bradstreet, Ratios of Manufacturing 1973-1977; 1978 Arthur D. Little, Inc., estimates.

b. U.S. Department of Commerce, Census of Manufactures, 1972 and 1977, and Annual Survey of Manufactures, 1973-1976; 1978 Arthur D. Little, Inc., estimates.

TABLE F-17

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE INORGANIC CHEMICAL INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Chlor-Alkali – Mercury Cell (SIC 2812)	139.90	1.92	1.16	0.71	0.32	0.60	4.73	3.49	2.50
Chlor-Alkali – Diaphragm Cell (SIC 2812)	319.60	2.68	1.65	1.09	0.56	1.96	7.95	7.23	2.26
Chrome Pigments (SIC 2816)	27.09	0.41	0.26	0.07	0.14	0.26	1.14	0.96	3.58
Titanium Dioxide – Sulfate (SIC 2816)	104.79	0.65	0.15	0.29	0.19	1.47	2.77	3.66	3.50
Titanium Dioxide – Chloride/Chloride Ilmenite (SIC 2816)	208.4	0.69	0.26	0.36	0.21	0.77	2.32	2.59	1.24
Sodium Dichromate (SIC 2819)	45.90	0.60	0.10	0.24	0.07	0.24	1.16	1.11	2.44
Boric Acid (SIC 2819)	23.00	0.01	0.00	0.00	0.00	0.05	0.08	0.12	0.56
Phosphorus Pentasulfide (SIC 2819)	24.00	0.01	0.03	0.00	0.02	0.00	0.07	0.05	0.24
Phosphorus Trichloride (SIC 2819)	29.50	0.00	0.02	0.00	0.00	0.00	0.03	0.01	0.06

a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Estimates by Arthur D. Little, Inc., based on industry data from Arthur D. Little, Inc., and Energy and Environmental Analysis, Inc.

(2) Economic Impact

Quantitative impact analyses were carried out for the chlor-alkali, sodium dichromate, chrome pigments, and titanium dioxide segments of the inorganic chemical industry. The cost estimates indicate maximum and immediate impact.

There are no significant economic impacts predicted for three of the seven industry segments: titanium dioxide-chloride process, titanium dioxide-chloride ilmenite process, and chrome pigments (Table F-18). Assuming full pass-through of costs, none of these model plants would incur price rises large enough to cause a significant drop in sales. Similarly, if forced to absorb all control costs out of profits, the model plants would remain profitable and economically viable.

Significant impacts and, in some cases, possible closures were identified in the sodium dichromate, chlorine-mercury process, chlorine-diaphragm process, and titanium dioxide-sulfate process segments. Each of these segments is discussed below.

The smallest sodium dichromate model plant incurs a large price increase of 15.7%. If forced to absorb all costs, rather than charge higher prices, the model becomes slightly unprofitable. These results suggest that the single real plant represented by the model may close.

On the other hand, if the plant remains open, it will have a market for its product. Demand for sodium dichromate, while not growing rapidly, is secure for the firms already in the market. There is no substitute in most applications, and no foreign competition. Domestic demand is strong enough to easily support the three existing plants; if the smallest one were to close, the remaining plants could not satisfy current demand even at 100% capacity utilization.

The next most likely closure candidates are found among the small chlorine-diaphragm and chlorine-mercury process plants. Nine of the 11 small mercury process plants incur large price rises, producing a composite price rise among all small plants of 11.4%. These plants are estimated to be unprofitable before the addition of any RCRA costs and the price increase is too large to pass on to consumers. Of the 12 small diaphragm process plants, two appear to be closure candidates, with a composite price increase of 12.5%. These plants are also unprofitable in the baseline, and could not be expected to be able to pass on to customers price increases of this magnitude.

While the impacts are severe, it is unlikely that all of these plants would close, however. The model plant analysis indicates that these plants are currently unprofitable, even without considering the RCRA costs, due to excess industry capacity and increases in operating supply costs. The plants apparently stay open because of two major factors. First, 60% of chlorine production is used "captively" in other manufacturing operations. The economics of the chlorine production step are thus less important than the profitability of the entire production process in which the chlorine facility is only one portion. Second, chlorine production produces the chemical sodium hydroxide (caustic soda) as a co-product. Caustic soda demand is

TABLE F-18

ECONOMIC IMPACT ON THE INORGANIC CHEMICAL INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases[a]	U.S. Demand Reduction	Balance of Payments Effects
Chlor-Alkali Mercury Cell							
1)	11	9[b]	153	0	11.6	0	0
2)	14	0	0	0	2.5	0	0
3)	2	0	0	0	1.8	0	0
Chlor-Alkali Diaphragm Cell[c]							
1)	12	2[b]	46	0	2.1%	0	0
2)	17	0	0	0	1.0	0	0
3)	11	0	0	0	1.0	0	0
Chrome Pigments							
1)	5	0	0	0	1.1	0	0
2)	3	0	0	0	0.6	0	0
3)	2	0	0	0	0.4	0	0
4)	2	0	0	0	0.3	0	0
Titanium Dioxide-Chloride							
1)	3	0	0	0	1.2	0	0
2)	2	0	0	0	1.0	0	0
3)	1	0	0	0	0.2	0	0
Titanium Dioxide-Sulfate							
1)	2	2	562	0	4.2	0	0
2)	1	0	0	0	2.0	0	0
3)	1	0	0	0	1.2	0	0

TABLE F-18 (Continued)

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases[a]	U.S. Demand Reduction	Balance of Payments Effects
Titanium Dioxide-Ilmenite							
1)							
2)							
3)							
4)	3	0	0	0	0.4	0	0
Sodium Dichromate							
1)	1	0	0	0	15.7	0	0
2)	1	0	0	0	4.7	0	0
3)	1	0	0	0	0.9	0	0
Boric Acid	4	possible	possible	possible	probable	probable	negligible
Phosphorus Pentasulfide	8	unlikely	unlikely	unlikely	possible	possible	negligible
Phosphorus Trichloride	7	negligible	negligible	negligible	negligible	negligible	negligible

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a. Assumes full pass-through of all costs, including closure fund.

b. Some, possibly most, of these chlorine operations are part of larger industrial installations. This reduces the possibility that all of these plants would actually close.

c. Only six diaphragm-process plants are subject to RCRA regulation, two plants in each size category. Because of the small number of impacted plants, the size of the category-wide price impacts is small or insignificant.

1) = small plant
2) = medium-sized plant
3) = large plant
4) = extra-large plant

Source: Energy and Environmental Analysis, Inc. (quantitative) and Arthur D. Little, Inc. (qualitative) estimates. The Energy and Environmental Analysis, Inc. quantitative impacts were based on incremental costs generated by Arthur D. Little, Inc., December 1980, which were different from those shown in Table F-17.

currently strong, and may generate enough revenue and profit to encourage plants to remain open. These factors will probably prevent some of the small chlorine plants from closing. (If all of them were to close, an estimated 199 people would lose their jobs.)

The remaining closure candidates are the two plants represented by the smallest titanium dioxide-sulfate process model (Table F-18). Plants of this type have been operating at an increasing competitive disadvantage in recent years. They are less economical than chloride process plants and much less economical than the three very large and low-cost chloride-ilmenite process plants du Pont has opened. Comparatively low-cost imports are also available. Given that titanium dioxide is a high-cost chemical with a relatively high price-elasticity of demand, sulfate plants have found it difficult to compete with the lower cost producers. Over the long term, it appears from this analysis that most sulfate plants will be closed. In this environment, the 4.2% price rise projected for the smallest sulfate process model probably could not be successfully passed on to customers. Therefore, the RCRA costs could accelerate closures by these plants.

If the model were to absorb all control costs, it would be only marginally profitable. Rather than maintain the two actual plants represented by the model as marginal operations, especially given the deteriorating competitive position of sulfate plants, it appears more likely that the large chemical firms that own the plants would shut them down. If both plants were to close, an estimated 562 jobs would be lost. The remaining U.S. plants have sufficient unused capacity that they could satisfy the demand supplied by these plants.

Qualitative impact analyses were carried out for boric acid, phosphorus pentasulfide, and phosphorus trichloride (Table F-18).

Price increases are probable in the boric acid segment (chance of occurrence 51-75%). This is expected to trigger a reduction in the growth of demand for boric acid and could possibly (chance 26-50%) lead to U.S. production cutbacks that could, in turn, lead to plant closures and job losses. Increased imports are a negligible possibility (chance 0.5-10%).

Plant closures, job losses, and production cutbacks are unlikely (chance 11-25%) in the phosphorus pentasulfide segment. Price increases and demand reduction are possible, however. There is a negligible chance that imports will increase.

Phosphorus trichloride plants are expected to bear negligible economic impacts.

6. THE PLASTIC MATERIALS, SYNTHETIC RUBBERS, AND SYNTHETIC FIBERS INDUSTRY (SIC 2821, 2822, 2823, 2824)

a. Characterization of the Plastic Materials, Synthetic Rubbers, and Synthetic Fibers Industry

(1) Industry Description

The "polymer industry," broadly defined, contains four distinct segments: plastic materials and resins (SIC 2821); synthetic rubbers (SIC 2822); man-made cellulosic fibers (SIC 2823); and man-made noncellulosic fibers (SIC 2824). These segments manufacture polymers (organic chemicals of high molecular weight made by combining one or more types of other chemicals in a process known as polymerization) for use by the packaging, building/construction, transportation equipment (e.g., automotive), apparel, toy, and many other industries. Petroleum and feedstocks, e.g., naphtha and ethane derived from natural gas, are the most important basic raw materials for this industry. Thus, the availability and price of these starting materials are of key importance. Plants in this industry are spread throughout the United States. Latest employment is estimated at about 160,000.

(2) Segmentation

To assess the economic impact of the ISS, the polymer industry was divided into 12 segments. Hazardous waste that is not already being incinerated is generated primarily in the production of phenolic resins, amino resins, alkyd resins, polypropylene, ABS/SAN resins, polystyrene, coumarone-indene resins, styrene-butadiene (SB) rubber, polybutadiene, neoprene, and rayon and acrylic fibers (Table F-19).

(3) Structure

The polymer industry varies in its degree of concentration. While the top four producers account for only 27% of industry segment capacity in the plastic materials and resins segment (SIC 2821), the top four producers in the cellulosic man-made fibers segment (SIC 2823) account for 96% of capacity.

(4) Supply and Demand

Historically, the polymer industry has grown much faster than most other manufacturing sectors. This rate of growth has decreased significantly, however, in the past 5 years. Given the availability of raw materials, unit demand is expected to grow at an industry average of 3-4% per year over the 1978-1983 period. The use of plastics continues to expand in a wide range of end products including flexible packaging and rigid containers, automobile parts, pipe, siding, etc. The elasticity of demand is generally moderate, although product substitution ranges from low to high depending on the product (Table F-19).

TABLE F-19

ECONOMIC CHARACTERIZATION OF THE PLASTIC MATERIALS, SYNTHETIC RUBBERS, AND SYNTHETIC FIBERS INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Total Industry (SIC 282)	28,000 39[a]	26,000	85	310	561	27-96	3-4	moderate	low to high	low
Phenolic Resins (SIC 2821)	570 33[a]	875	60-65	55	120	30-35	2-3	moderate	low	low
Amino Resins (SIC 2821)	290 33[a]	729	60-65	106	215	25-35	2-3	moderate	low	low
Coumarone-Indene Resins (SIC 2821)	81 33[a]	145	60-65	2	4	80	2-3	moderate	low	low
Polystyrene Resins (SIC 2821)	1,019 33[a]	1,738	70	16	36	45-55	2-3	moderate	low	low
Polypropylene Resins (SIC 2821)	704 33[a]	1,389	75	11	15	50-60	8-9	moderate	low	low
ABS/SAN Resins (SIC 2821)	900 33[a]	696	80	7	13	85-90	3-4	moderate	low	low
Alkyd Resins (SIC 2821)	205 33[a]	343	60-65	73	140	5-15	0-1	moderate	low	low
SB Rubber (SIC 2822)	888 31[a]	1,360	80	9	9	65-70	0-1	moderate	low	low
Polybutadiene Rubber (SIC 2822)	396 31[a]	380	90	5	5	85-90	3-4	moderate	low	low
Neoprene Rubber (SIC 2822)	270 31[a]	161	90	2	4	100	4-5	moderate	low	low
Rayon Fibers (SIC 2823)	1,085 33[a]	411	95	4	4	100	1-2	moderate	low	low
Acrylic Fibers (SIC 2824)	640 45[a]	350	85	5	6	95	3-4	moderate	low	low

a. Value added as a percent of production value.

Sources: U.S. International Trade Commission, Synthetic Organic Chemicals, U.S. Production and Sales, 1978.

(5) Profitability

Profit margins improved from 1976 to 1979 along with the general economy. In 1974 and again in 1978, they exceeded 1972 pre-oil embargo levels (Table F-20).

(6) Capital Investment

The polymer industry is relatively capital-intensive. For example, in 1979 the ratio of investment to net sales was about 0.77, whereas the ratio for all U.S. industry taken as a whole was about 0.52. New capital expenditures more than doubled between 1972 and 1977 when the annual rate of expenditures in this industry approached roughly $1.3 billion.

b. Economic Impact on the Plastic Materials, Synthetic Rubbers, and Synthetic Fibers Industry

(1) Cost of Compliance

Table F-21 shows the estimated incremental annual cost of compliance with the ISS. Total first-year expenditures of $25 million and total annual costs of $29 million to comply with the regulations seem quite low, considering the $26 billion in shipments of the plastics, synthetic rubbers, and synthetic fibers industry. The reason for this relatively low expenditure requirement is that most hazardous wastes in the polymer industry are already being incinerated, employing procedures that meet RCRA standards. Thus, the costs shown here pertain only to that portion of the hazardous waste produced by the roughly 25% of the industry that cannot be incinerated.

The only segment of the polymer industry that appears to be facing a significant impact is phenolic resins. The total annual cost per plant in this segment is expected to amount to about $185,000. Furthermore, large plants with surface impoundments could incur annual costs per plant in excess of $700,000, which would amount to about 30% of the value added for these plants.

(2) Economic Impact

With some phenolic resin plants experiencing such high costs to comply with the ISS, plant closures in this segment are considered probable (chance of occurrence 51-75%). Some employees in plants located in a chemical complex may be absorbed by other production operations within the complex. Nevertheless, job losses are still considered possible (chance 26-50%) because not all phenolic resin plants are in complexes and even within a complex, it may not be possible to absorb all employees of a shut-down plant.

Price increases are considered likely (chance greater than 75%) for the surviving phenolic resin plants. There is practically no international trade in phenolic resins; thus, the balance of payments is not expected to be affected. Excess capacity in the segment will permit production lost from closed facilities to be made up by other plants producing phenolic resins (Table F-22).

TABLE F-20

FINANCIAL PROFILE OF THE PLASTIC MATERIALS, SYNTHETIC RUBBERS, AND SYNTHETIC FIBERS INDUSTRY

(1972-1978)

Total Industry (SIC 28)		1978	1977	1976	1975	1974	1973	1972
Profitability[a]								
Net Income After Taxes/Net Sales (%)	upper quartile	7.63	6.01	4.28	4.58	6.89	6.31	6.40
	median	4.44	3.42	3.25	2.80	5.27	3.80	4.14
	lower quartile	1.91	2.30	1.69	1.21	2.18	2.36	2.54
(Net Profits on Net Sales)								
Net Income After Taxes/Net Worth (%)	upper quartile	26.17	19.38	11.30	16.60	21.66	16.50	18.17
	median	16.78	11.96	8.81	7.81	13.92	11.89	11.30
	lower quartile	11.33	6.74	5.46	3.64	8.52	4.75	6.36
Revenues[b]								
Value of Shipments ($ Million)		26,000	19,874	17,155.5	14,348.6	16,108.1	11,719.6	9,798.9
Value Added/Shipments (%)		39.0	38.5	38.7	38.4	46.9	51.8	50.4
New Capital Expenditures ($ Million)		NA	1,282.4	1,368.6	1,439.4	1,276.6	829.8	686.4

Sources:
a. Dun and Bradstreet, Ratios of Manufacturing, 1973-1978 (SIC: 2821, 22, 23, 24).
b. U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1972 and 1977, and Annual Survey of Manufactures 1973-1976 and 1978.

TABLE F-21

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE PLASTIC MATERIALS, SYNTHETIC RUBBERS, AND SYNTHETIC FIBERS INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Phenolic Resins (SIC 2821)	188.00	4.77	1.49	8.58	0.95	2.30	18.11	22.30	11.86
Amino Resins (SIC 2821)	96.00	0.08	0.60	0.05	0.03	0.16	0.93	0.56	0.58
Coumarone-Indene Resins (SIC 2821)	27.00	0.01	0.01	0.00	0.01	0.05	0.08	0.11	0.43
Polystyrene Resins (SIC 2821)	336.00	0.43	0.13	0.46	0.12	0.13	1.31	1.41	0.42
Polypropylene Resins (SIC 2821)	232.00	0.20	0.04	0.22	0.06	0.05	0.58	0.63	0.27
ABS/SAN Resins (SIC 2821)	297.00	0.13	0.04	0.11	0.04	0.03	0.38	0.38	0.13
Alkyd Resins (SIC 2821)	68.00	0.00	0.33	0.00	0.00	0.09	0.43	0.23	0.34
SB Rubber (SIC 2822)	278.00	0.01	0.02	0.00	0.02	0.06	0.12	0.16	0.06
Polybutadiene Rubber (SIC 2822)	123.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
Neoprene Rubber (SIC 2822)	84.00	0.01	0.02	0.01	0.02	0.05	0.13	0.17	0.21
Rayon Fibers (SIC 2823)	358.00	0.33	0.13	0.18	0.10	0.21	0.95	0.94	0.27
Acrylic Fibers (SIC 2824)	245.00	0.53	0.14	0.47	0.13	0.41	1.70	1.96	0.80

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-22

ECONOMIC IMPACT ON THE PLASTIC MATERIALS, SYNTHETIC RUBBERS, AND SYNTHETIC FIBERS INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Phenolic Resins	120	probable	possible	none	likely	negligible	none
Amino Resins	215	none	none	none	negligible	none	none
Coumarone-Indene Resins	4	none	none	none	negligible	none	none
Polystyrene Resins	36	none	none	none	unlikely	none	none
Polypropylene	15	none	none	none	unlikely	none	none
ABS/SAN Resins	13	none	none	none	negligible	none	none
Alkyd Resins	140	none	none	none	negligible	none	none
SB Rubber	9	none	none	none	negligible	none	none
Polybutadiene Rubber	5	none	none	none	none	none	none
Neoprene Rubber	3	none	none	none	negligible	none	none
Rayon Fibers	4	none	none	none	negligible	none	none
Acrylic Fibers	6	none	none	none	unlikely	none	none

Source: Arthur D. Little, Inc., estimates.

For the other segments of the polymer industry that may incur compliance costs, the level of required expenditures is low enough that no significant impact is expected.

In summary, under the ISS, plant closures and other adverse economic effects are not expected in the plastic materials, synthetic rubbers, and synthetic fibers industry. Plants in the segments affected are expected to be able to raise prices to cover the cost of the regulations (Table F-22).

7. THE PHARMACEUTICAL INDUSTRY (SIC 2831, 2833, 2834)

a. Characterization of the Pharmaceutical Industry

(1) Industry Description

The pharmaceutical industry provides active therapeutic substances in stable and useful dosage forms such as tablets, injectables, capsules, and the like. The manufacturing process for most pharmaceuticals involves two stages: 1) producing medicinally active ingredients, and 2) formulating and packaging the final dosage forms. For the purposes of this report, it is important to note that the plants producing active ingredients generate most of the hazardous wastes of the industry.

(2) Segmentation

The U.S. Department of Commerce divides the drug industry into three SIC categories: producers of biological products (SIC 2831), producers of medicinal chemicals and botanical products (SIC 2833), and producers of pharmaceutical preparations (SIC 2834). Producers of biological products (SIC 2831) manufacture bacterial and virus vaccines, toxoids and allergenic extracts, serums, plasmas, and other blood derivatives for human and veterinary use. Producers of medicinals and botanicals (SIC 2833) manufacture bulk organic and inorganic chemicals and their derivatives such as antibiotics, sulfa drugs, vitamins, etc., as well as drugs extracted from plants such as opium, nicotine, digitalis, ginseng, etc. SIC 2831 covers both production of active ingredients and the formulating and packaging functions, but the principal hazardous wastes come from the production of active ingredients. SIC 2833 covers only the production of such active ingredients as bulk organic and inorganic medicinal chemicals utilized in formulating products by plants in SIC 2834. SIC 2834 is essentially the same as the formulation and packaging function mentioned above. Many firms concentrate on formulation and packaging alone, but most of the large pharmaceutical houses producing finished pharmaceuticals are integrated backward to the production of some active ingredients.

Conversely, many of the plants classified by the Department of Commerce in SIC 2833 are owned by organic chemical companies or are small independent chemical companies. These companies do not produce finished pharmaceutical dosage forms and hence are suppliers to the pharmaceutical industry.

In 1978, the total pharmaceutical shipments of the plants in SIC 2831, 2833, and 2834 amounted to approximately $14 billion. Table F-23 presents detailed information on these three segments of the industry. Production of active ingredients in SIC 2833 is expected to grow 4-6% annually through 1983. The production tonnage of finished pharmaceuticals is not recorded and is also not a meaningful measure of the industry. The dollar value of finished pharmaceuticals in SIC 2831 and 2834 is expected to grow at an annual rate of 3-5% in constant dollar terms. The industry employs approximately 151,000 people.

(3) Structure

As Table F-23 shows, there are 1100 plants in the three segments of the pharmaceutical industry. Many of these plants are small and only 477 have more than 20 employees each. The top four firms in the SIC 2831 segment have 35% of the market, and in SIC 2833 the top four firms have 60% of the shipment value of active ingredients. While there are some large firms in the business of making pharmaceutical preparations (SIC 2834), the four largest have only 25% of the market and no single firm has more than 7-8%.

(4) Supply and Demand

Although a growth of 3-6%/year is expected for various segments of the pharmaceutical industry through 1983, the capital appropriations required are expected to be forthcoming and no supply constraints are anticipated.

Because the active ingredients are highly application-specific, there is only modest product substitution in this stage of the pharmaceutical industry and import competition is low to moderate. Thus, price elasticity of demand is low. Product substitutes are frequently available at the formulation and packaging level, but there is little import competition and price elasticity of demand is low to moderate.

(5) Profitability

Profitability varies significantly among companies. In general, profits as a percent of sales have been relatively stable from 1972 to 1977 at a median level of about 6.5% after taxes (Table F-24). On the other hand, after-tax profit as a percent of net worth peaked at 16% in 1974 and varied from 12.8% to 15.7% for the average firm in the industry during the 1972-1977 period. Even though these rates of return appear to be good, the profitability of companies in the bottom quartile of the industry was quite low in 1977, less than 1% of sales and less than 2% of net worth. Firms operating at these lower levels of profitability may be most seriously affected by the hazardous waste management regulations, if they have significant hazardous waste loads. The profitability of the three SIC categories of the industry is shown in Table F-25.

TABLE F-23

ECONOMIC CHARACTERIZATION OF THE PHARMACEUTICAL INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Biological Products (SIC 2831)	996 (61.0%)[a]	N.A.	80	260	304	35	3-5	low	low	low
Medicinals and Botanicals (SIC 2833)	2,277 (61.0%)	64	80	160	179	60	4-6	low to moderate	low	low to moderate
Pharmaceutical Preparations (SIC 2834)	10,734 (72.0%)	N.A.	80	680	757	25	3-5	moderate	moderate	low

a. Value added as a percent of production value

Sources: Arthur D. Little, Inc., estimates based on U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977 Preliminary Report; International Trade Commission, Synthetic Organic Chemicals 1978, published in 1979.

TABLE F-24

FINANCIAL PROFILE OF THE PHARMACEUTICAL INDUSTRY

(1972-1977)

Total Industry (SIC 283)		1977	1976	1975	1974	1973	1972
Profitability[a]							
Net Income After Taxes/Net Sales (%)	upper quartile	10.35	10.54	10.16	11.01	9.41	9.31
	median	6.70	6.62	6.15	6.73	6.05	6.10
	lower quartile	0.83	2.84	3.27	3.30	2.51	2.48
Net Income After Taxes/Net Worth (%)	upper quartile	23.03	16.76	18.86	21.42	21.36	20.54
	median	15.67	13.71	14.37	15.29	13.40	12.76
	lower quartile	1.86	3.43	7.46	9.80	6.87	4.46
Revenues[b]							
Value of Shipments ($ Million)		14,436.1	13,016.3	11,232.1	9,897.3	8,749.5	8,018.5
Value Added/Shipments (%)		69.8	71.6	71.4	73.4	75.7	76.4
New Capital Expenditures ($ Million)		592.1	471.2	475.0	400.2	259.1	245.3

Sources:

a. Dun and Bradstreet, Ratios of Manufacturing, 1972-1976; Robert Morris Associates, Annual Statement Studies, 1978.

b. U. S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures, 1973-1976; Census of Manufactures, 1972 and 1977. Revenue data includes receipts for products classified in other industries and miscellaneous receipts which includes sale of scrap, research and development payments, resales, etc. Thus, the pharmaceutical receipts are overstated by an amount that increases from $435 million in 1972 to an estimated $1,600 million in 1977.

TABLE F-25

FINANCIAL PROFILE OF THE PHARMACEUTICAL INDUSTRY BY SEGMENT (1978)

	Biological Products (SIC 2831)	Medicinals and Botanicals (SIC 2833)	Pharmaceutical Preparations (SIC 2834)
Profitability[a]			
Net Income After Taxes/Net Sales (%)		Not Available	
Net Income After Taxes/Net Worth (%)			
Net Income After Tax/Value Added (%)			
Revenues			
Value of Shipments ($ Million)	996[b]	2,277[b]	10,734[c]
Value Added/Shipments (%)	60.9	61.0	72.0

Sources: a. No published data for 1978.
b. U.S. Department of Commerce, U.S. Industrial Outlook, 1980.
c. Arthur D. Little, Inc., estimates.

(6) Capital Investment

New annual capital expenditures for the U.S. pharmaceutical industry grew rather steadily between 1972 and 1977 from $250 million to $592 million. These data do not include substantial investments made in recent years in the Commonwealth of Puerto Rico.

b. Economic Impact on the Pharmaceutical Industry

(1) Cost of Compliance

Table F-26 shows the estimated incremental annual cost of compliance with the ISS. For the pharmaceutical preparations segment (SIC 2834), which produces very little hazardous waste, the costs in the first year are expected to be about $2.5 million. Capital costs will probably be minimal. As a result, the annual cost of the regulations as a percent of value added for the pharmaceutical preparations segment is estimated to be only 0.02%.

Plants in the biological products segment (SIC 2831) are generally in integrated companies. Prior to the promulgation of the RCRA regulations, these companies were autoclaving or incinerating hazardous wastes. Thus, the first-year incremental expenditures attributable to the regulations for this segment are only $1.1 million, of which very little will be for new capital equipment. Thus, the annual cost of the regulations as a percent of value added for the biological products segment is expected to be only 0.10%.

On the other hand, the medicinals and botanicals segment (SIC 2833) is expected to incur a total first-year expenditure of about $7.5 million, of which $1.4 million will be capital costs and another $1 million will be closure fund expenditures. The annual cost of the regulations as a percent of value added for the medicinals and botanicals segment is expected to average almost 0.5%. Some of the small firms in the industry, however, are expected to incur costs that will be more than 15% of value added. The percentage impact on larger firms is likely to be less than 0.2%.

(2) Economic Impact

Because of the relatively large percentage impacts of the ISS regulations on the small plants in the medicinals and botanicals segment (SIC 2833), closure of some of these plants is considered likely (chance of occurrence greater than 75%) (Table F-27). Some process units of larger plants may also be shut down. The potential for closures is greater in this segment because of the lower profitability of these producers, who are generally companies in the organic chemical industry rather than in the pharmaceutical industry.

Along with the plant shutdowns will come job losses in the medicinals and botanicals segment. The larger firms in this segment are expected to raise prices in an attempt to cover cost increases incurred because of RCRA. Since operating rates

TABLE F-26

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE PHARMACEUTICAL INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Biological Products (SIC 2831)	607.00	0.00	0.85	0.00	0.02	0.21	1.10	0.68	0.10
Medicinals and Botanicals (SIC 2833)	1,389.00	1.43	3.03	1.04	0.77	1.39	7.68	6.54	0.47
Pharmaceutical Preparations (SIC 2834)	7,728.00	0.00	1.93	0.00	0.02	0.52	2.48	1.31	0.02

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-27

ECONOMIC IMPACT ON THE PHARMACEUTICAL INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Biological Products (SIC 2831)	304	none	none	none	none	none	none
Medicinals and Botanicals (SIC 2833)	179	likely[a]	likely	none	likely	none	none
Pharmaceutical Preparations (SIC 2834)	757	none	none	none	none	none	none

[a] Some of these closures will be process unit shutdowns rather than whole plants.

Source: Arthur D. Little, Inc., estimates.

will permit the larger firms to increase production of the affected products, demand reduction, production cutbacks, and balance of payment effects are not expected.

Because the RCRA-induced cost increases for the biological products and pharmaceutical preparations segments are expected to be small, no adverse economic impacts are expected for these segments of the industry.

8. THE PAINT AND ALLIED PRODUCTS INDUSTRY (SIC 2851)

a. Characterization of the Paint and Allied Products Industry

(1) Industry Description

The paint and allied products industry consists of approximately 1300 producers operating 1500 plants. In 1978 the industry shipped product valued at $7.3 billion. Shipments of paints are estimated to have been about $6 billion or around 80% of total shipments. "Allied" products such as varnishes, lacquers, enamels, putties, wood fillers and sealers, paint and varnish removers, paint brush cleaners, thinners, and dryers made up the other $1.3 billion.

The paint segment of the industry can be divided into two parts: trade sales paints and industrial coatings. Trade sales paints are sold through wholesalers and retailers to the general public and to professional painters. Producers in this segment manufacture both exterior and interior products in either organic solvent or water-borne formulations. Most plants manufacture a limited number of standard colors along with tinting bases that can be used with a coloring system to blend a wide variety of shades or hues at the point of sale in response to customer demand. The industrial coatings segment produces such products as coil coatings, automotive and appliance finishes, and industrial maintenance coatings.

(2) Segmentation

For purposes of this study, producers of both trade sales paints and industrial paints have been analyzed together.

(3) Structure

The four-firm concentration ratio for the paint and allied products industry is a relatively low 20-25%.

(4) Supply and Demand

Unit demand for paint and allied products is expected to grow less than 2%/year through 1983. The low capacity utilization rate of 45% is calculated on a two-shift basis, which is the industry norm. Therefore, no supply constraints are anticipated over the next five years (Table F-28). Product substitution is moderate in the paint industry and imports are low.

TABLE F-28

ECONOMIC CHARACTERIZATION OF THE PAINT AND ALLIED PRODUCTS INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Million liters)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Paints and Allied Products (SIC 2851)	7,320 (43%)[a]	3,819	45[b]	1,300	1,500	25-30	<2	moderate	moderate	low

a. Value added as a percent of production value

b. Assumes minimum two-shift operation

Sources: Arthur D. Little, Inc., estimates based on U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977 Preliminary Report; Kline Guide to the Paint Industry, Joan Huber, Ed., 1978.

(5) Profitability

Profitability as measured in terms of net income after taxes as a percent of sales remained relatively stable at just over a median of 2.5% from 1972-1977 (Table F-29). After-tax profits are particularly low for companies operating in the lower quartile. This group will be most adversely affected by the hazardous waste management regulations. In 1978 profitability improved to 3.9%; net income after taxes as a percentage of value added was 9.0% (Table F-30). These data are skewed to the high side by large companies for which paints are a minor percentage of total sales.

(6) Capital Investment

Capital investment in the paint industry has been growing slowly but steadily over the past six years and approached $168 million in 1977. Further investments will be required by the industry to develop paints with a low solvent content to meet EPA air quality regulations. Priorities are also shifting to more energy-efficient production facilities.

b. Economic Impact on the Paint and Allied Products Industry

(1) Cost of Compliance

Table F-31 shows the estimated incremental annual cost of compliance with the ISS. The paint industry is expected to incur a capital cost in the first year of almost $4 million or roughly $2500 for the average plant. The total first-year cost is estimated at almost $22,000 per plant.

For the average plant the total annual cost as a percent of value added is expected to be almost 0.7%. This percentage could be roughly 8% for small plants with surface impoundments, while it may be as low as 0.1% for large plants without surface impoundments.

(2) Economic Impact

Given the relatively large cost burden of the ISS on the paint industry and the industry's low profit margins, plant closures and job losses are considered likely (chance of occurrence greater than 75%) (Table F-32).

The competitive nature of the industry and its substantial overcapacity are expected to make it difficult to increase prices to cover RCRA costs. Nevertheless, price increases are possible (chance 26-50%). Production cutbacks, U.S. demand reduction, and balance of payments effects are considered negligible (chance 0.5-10%).

TABLE F-29

FINANCIAL PROFILE OF THE PAINT AND ALLIED PRODUCTS INDUSTRY

(1972-1977)

Total Industry (SIC 2851)		1977	1976	1975	1974	1973	1972
Profitability[a]							
Net Income After Taxes/Net Sales (%)	upper quartile	4.82	4.36	4.66	4.58	3.64	3.96
	median	2.61	2.80	2.71	2.52	2.61	2.61
	lower quartile	1.01	1.26	1.46	1.29	1.52	1.50
Net Income After Taxes/Net Worth (%)	upper quartile	16.29	16.61	13.13	14.66	11.86	12.91
	median	8.63	8.96	9.05	9.00	8.49	8.87
	lower quartile	1.45	4.12	3.82	4.38	4.19	5.39
Revenues[b]							
Value of Shipments ($ Million)		6,658.5	5,931.3	5,149.0	5,007.0	4,268.3	3,824.3
Value Added/Shipments (%)		42.7	43.19	41.29	44.48	45.91	46.86
New Capital Expenditures ($ Million)		167.8	122.4	121.8	119.1	72.5	81.5

Sources: a. Dun and Bradstreet, Ratios of Manufacturing.

b. U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures, 1972-1976, and Census of Manufactures, 1977.

TABLE F-30

FINANCIAL PROFILE OF THE PAINT AND ALLIED PRODUCTS INDUSTRY

(1978)

Profitability[a]	
Net Income After Taxes/Net Sales (%)	3.0
Net Income After Taxes/Net Worth (%)	16.0
Net Income After Tax/Value Added (%)	7.0
Revenues[b]	
Value of Shipments ($ Million)	7,320
Value Added/Shipments (%)	56

Sources:

a. Operating Highlights, Paint Industry, National Paint and Coatings Association.

b. U.S. Department of Commerce, U.S. Industrial Outlook, 1980.

TABLE F-31

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE PAINT AND ALLIED PRODUCTS INDUSTRY

Industry Segment	1978 Value Added ($ Million)	Cost of Waste Management at the Generator Plant: First Year: Capital ($ Million)	Cost of Waste Management at the Generator Plant: First Year: One-Time Expenses ($ Million)	Cost of Waste Management at the Generator Plant: Annual: Closure Fund[a] ($ Million)	Cost of Waste Management at the Generator Plant: Annual: Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Paints and Allied Products (SIC 2851)	3,150.00	3.71	19.34	1.05	3.26	5.48	32.86	21.57	0.68

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1614.

Source: Arthur D. Little, Inc., estimates.

TABLE F-32

ECONOMIC IMPACT ON THE PAINT AND ALLIED PRODUCTS INDUSTRY

Industry Segment	Number of Existing Plants In 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Paint and Allied Products (SIC 2851)	1500	likely	likely	negligible	possible	negligible	negligible

Source: Arthur D. Little Inc., estimates.

9. THE ORGANIC CHEMICAL INDUSTRY (SIC 28612, 28651, 28692)

a. Characterization of the Organic Chemical Industry

(1) Industry Description

Organic chemicals contain carbon in a form similar to that of plants and animals. They are generally combustible, frequently insoluble in water, and usually either liquids or low-melting solids. Commercially, there are three important types: (1) basic organics obtained directly from the primary raw material — petroleum, natural gas, or coal tar; (2) intermediates manufactured from basic chemicals, but used in turn as raw materials for the synthesis of still other chemicals; and, (3) end products that are not further altered chemically, but are often either formulated with other materials for a specific industrial or commercial application or used by other industries for fabricating their products. Basic and intermediate organic chemicals are largely commodity products produced in relatively large volumes and sold at lower prices than most end product chemicals.

Basic and intermediate organics are raw materials for all other organic chemicals, and therefore, are produced by many chemical companies and the chemical divisions of major oil companies. Since the minimum economic scale plant for most organic chemicals is quite large, the overall concentration ratio for this industry is high, especially for specialty products. For the largest-volume commodity chemicals, typically produced in billion pound quantities annually, the concentration ratio is lower, however, with 25 or more producers in some cases. On the other hand, a number of important basic and intermediate organic chemicals are produced by only half a dozen, or even fewer, companies. The structure of the industry is generally oligopolistic, mainly because of the capital-intensive nature of the business and its economies of scale.

In 1978, the organic chemical industry shipped products valued at roughly $35 billion. Historically, the industry has grown significantly faster than the GNP. Real growth through 1983 will be lower than the historical rate, but is expected to exceed the growth of the economy as a whole by about 50%. The organic chemical segment of the chemical industry employs about 150,000 people.

(2) Segmentation

Not all segments of the organic chemical industry produce hazardous waste. This analysis focuses on segments of the industry known from a previous study* to be generators of hazardous waste. These segments are: perchloroethylene, nitrobenzene, chloromethanes, epichlorohydrin, toluene diisocyanate, vinyl chloride monomer, methyl methacrylate, acrylonitrile, maleic anhydride, lead alkyls, chlorobenzene, ethanolamines, furfural, benzylchloride, fluoromethanes, and ethylene dichloride. This is not considered an inclusive list of hazardous waste-producing organic chemicals, however. Further in-depth analysis of the industry is required in order to identify all hazardous waste-producing segments.

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*Gruber, G.I. Assessment of Industrial Hazardous Waste Practices: Organic Chemicals, Pesticides and Explosives Industries, April 1975. EPA Reference Number SW-118C.

(3) Structure

Several of the above segments of the organic chemical industry (epichlorohydrin, ethanolamines, furfural, acrylonitrile, benzylchloride, lead alkyls, and methyl methacrylate) have four-firm concentration ratios of 100%. The other segments under study are produced by a larger number of firms. Their concentration ratios range from 70 to 90% (Table F-33).

(4) Supply and Demand

Through 1983, the growth in unit demand for the organic chemicals under study is expected to almost equal the growth of the industry as a whole. Declines are expected for two segments, lead alkyls and fluoromethanes (Table F-33). Capacity utilization in 1978 for most of the segments was below the preferred range of 80-90%. The products with low operating rates included perchloroethylene (63%), nitrobenzene (65%), chloromethanes (63%), epichlorohydrin (52%), toluene diisocyanate (72%), methyl methacrylate (73%), maleic anhydride (63%), chlorobenzene (43%), ethanolamines (74%), benzylchloride (56%), fluoromethanes (63%), and ethylene dichloride (70%). Only four segments had operating rates in the preferred range or above it: vinyl chloride monomer (80%), acrylonitrile (85%), lead alkyls (97%), and furfural (100%). Given current market conditions and the industry structure, no significant supply constraints are anticipated through 1983.

All of the organic chemicals studied, except lead alkyls, nitrobenzene, ethylene dichloride, vinyl chloride monomer, and the chloromethane group, encounter a moderate to high degree of product substitution. At the present time, only three products, furfural, perchloroethylene, and acrylonitrile, face import competition. Imports are likely to become an increasing problem, however.

(5) Profitability

Profitability after taxes in the organic chemical industry fluctuated with the state of the economy between 1972 and 1978 (Table F-34). The average during those years was roughly 4% of sales and 13% of net worth. In 1978, after-tax profitability was 3.7% of sales and 11% of net worth. Barring a major recession, profitability is expected to improve gradually to 5% of sales and 15% of net worth through 1983.

(6) Capital Investment

The level of new capital investment in the organic chemical industry more than quadrupled between 1972 and 1977 (Table F-34). Capital expenditures include both productive investments leading to the capacity to produce more products and nonproductive investments for purposes of pollution control and energy conservation.

TABLE F-33

ECONOMIC CHARACTERIZATION OF THE ORGANIC CHEMICAL INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Nitrobenzene[b] (SIC 2861)	185 46[c]	380	65	5	7	90	5	low	low	low
Toluene Diisocyanate[b] (SIC 2865)	290 38[c]	273	72	8	10	80	5	moderate	moderate	low
Furfural[b] (SIC 2866)	105 38[c]	100	100	1	5	100	3	high	high	moderate
Benzylchloride[b] (SIC 2865)	40 38[c]	45	56	3	4	100	6	moderate	moderate	low
Perchloroethylene[a] (SIC 2869)	73 42[c]	330	63	7	10	75	1	moderate	moderate	moderate
Chloromethanes[a] (SIC 2869)	338 42[c]	969	63	11	17	70	3	moderate	some	low
Epichlorohydrin[b] (SIC 2869)	145 44[c]	147	52	2	3	100	2	some	moderate	low
Vinyl Chloride Monomer[a] (SIC 2869)	902 42[c]	3,155	80	11	15	70	6	low	some	low
Methyl Methacrylate[b] (SIC 2869)	312 44[c]	363	73	3	4	100	6	moderate	moderate	low
Acrylonitrile[a] (SIC 2869)	403 42[c]	796	86	4	6	100	5	some	moderate	some
Maleic Anhydride[b] (SIC 2869)	95 42[c]	151	63	8	10	80	5	moderate	moderate	low
Lead Alkyls[b] (SIC 2869)	595 44[c]	360	97	4	6	100	– 10	low	low	low
Chlorobenzene[b] (SIC 2869)	60 40[c]	135	43	6	6	80	3	moderate	moderate	low
Ethanolamines[b] (SIC 2869)	130 44[c]	165	74	4	5	100	2	moderate	moderate	low
Fluoromethanes[b] (SIC 2869)	364 44[c]	330	63	5	10	90	– 5	moderate	moderate	low
Ethylene Dichloride[a] (SIC 2869)	880 42[c]	5,000	70	11	18	74	5	low	low	low

a. Data developed by Temple, Barker and Sloane, Inc.
b. Data developed by Arthur D. Little, Inc.
c. Value added as a percent of production value.

Sources: Arthur D. Little, Inc. and Temple, Barker and Sloane, Inc. estimates.

TABLE F-34

FINANCIAL PROFILE OF THE ORGANIC CHEMICAL INDUSTRY

(1972-1978)

Total Industry (SIC 286)	1978	1977	1976	1975	1974	1973	1972
Profitability[a]							
Net Income After Taxes/Net Sales (%)	3.7	4.0	5.0	4.6	4.9	4.1	3.0
Net Income After Taxes/Net Worth (%)	11.0	13.0	16.0	15.0	18.0	12.0	8.0
Revenues[b]							
Value of Shipments ($ Million)	35,000	29,641.7	25,685.1	21,056.7	19,355.5	13,447.7	11,605.4
Value Added/Shipments (%)	42	42.7	44.2	46.2	48.2	51.3	52.3
New Capital Expenditures ($ Million)	NA	3,510.9	2,684.4	2,119.8	1,589.4	1,005.6	831.6

Sources: a. Arthur D. Little, Inc. estimates based on Robert Morris, Annual Statement Studies, 1973-1978.

b. U.S. Department of Commerce, Census of Manufactures, 1972 and 1977, and Annual Survey of Manufactures, 1973-1976, 1978 Arthur D. Little, Inc., estimates.

b. Economic Impact on the Organic Chemical Industry

(I) Cost of Compliance

Table F-35 shows the estimated incremental annual cost of compliance with the ISS.

Nitrobenzene manufacturing plants are estimated to have annual cost increases amounting to 0.3% of value added. The range for plants in this segment is narrow (0.2-0.4%). The annual cost per plant is expected to average about $25,000.

Plants manufacturing toluene diisocyanate face an average increase in cost as a percent of value added of almost 1.5%. The range is from about 3.0% for small plants with surface impoundments to less than 0.2% for small plants without surface impoundments. Furthermore, large first-year capital and closure costs make the burden of RCRA ISS greater on this segment. For the average plant, first-year costs are estimated to be about $150,000.

Plants manufacturing furfural are expected to encounter an average cost increase of about 2.3%. This will amount to expenditures of more than $180,000 per average plant annually. Since all the plants are about the same size, there is only a small variation in the cost per plant in this segment.

Plants producing benzylchloride face a cost increase of about 0.2% of value added, but the cost for small plants is estimated to be more than 1%.

For lead alkyl plants, the annual cost of the regulations as a percent of value added is estimated at about 0.25% or an average of roughly $112,000 per plant. Large producers with surface impoundments, however, face a cost of almost $250,000 per plant, more than twice the average.

Plants manufacturing maleic anhydride are expected to encounter a cost of compliance that is almost 0.44% of value added. The annual dollar expenditure is expected to average about $15,000 per plant.

Because few plants produce methyl methacrylate, a total annual cost of $550,000 means a cost per plant of almost $140,000. For large plants with surface impoundments, the average annual cost is estimated to be close to $250,000 per plant. The cost of the regulations averages 0.4% of value added for plants in this segment.

The cost impact varies widely for plants producing chlorobenzene. Average annual cost as a percent of value added is estimated at almost 0.7%, but small plants are expected to experience a cost increase of about 3.5%.

Plants manufacturing epichlorohydrin are expected to encounter annual cost impacts of about 0.15% of value added or an annual cost for the average plant of roughly $30,000.

TABLE F-35

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE ORGANIC CHEMICAL INDUSTRY

Industry Segment	1978 Value Added ($ Million)	Cost of Waste Management at the Generator Plant				Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
		First Year		Annual					
		Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)				
Nitrobenzene (SIC 2861)	86.00	0.01	0.04	0.00	0.02	0.11	0.20	0.25	0.30
Toluene Diisocyanate (SIC 2865)	110.00	0.60	0.06	0.69	0.07	0.06	1.49	1.60	1.46
Furfural (SIC 2865)	40.00	0.14	0.11	0.10	0.09	0.28	0.73	0.91	2.28
Benzylchloride (SIC 2865)	16.00	0.00	0.01	0.00	0.01	0.00	0.03	0.03	0.21
Lead Alkyls (SIC 2869)	262.00	0.17	0.10	0.25	0.08	0.01	0.62	0.67	0.26
Maleic Anhydride (SIC 2869)	42.00	0.01	0.03	0.00	0.02	0.05	0.13	0.16	0.38
Methyl Methacrylate (SIC 2869)	137.00	0.12	0.07	0.06	0.06	0.17	0.48	0.56	0.41
Chlorobenzene (SIC 2869)	24.00	0.01	0.02	0.00	0.01	0.06	0.12	0.16	0.69
Epichlorohydrin (SIC 2869)	64.00	0.01	0.02	0.01	0.01	0.02	0.08	0.09	0.15
Ethanolamines (SIC 2869)	57.00	0.01	0.00	0.00	0.01	0.12	0.16	0.25	0.45
Fluoromethanes (SIC 2869)	160.00	0.00	0.02	0.00	0.00	0.00	0.03	0.01	0.01
Acrylonitrile	166.80	0.03	0.06	0.02	0.02	1.10	1.24	2.07	1.24
Chloromethanes/ Perchloroethylene	170.2	0.09	0.19	0.04	0.04	0.03	0.40	0.27	0.16
Ethylene Dichloride/ Vinyl Chloride Monomer	209.5	0.04	0.16	0.03	0.02	0.04	0.31	0.21	0.16
EDC	196.8	0.01	0.04	0.00	0.00	0.00	0.07	0.04	0.02

a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Sources: Estimates by Arthur D. Little, Inc., based on industry data provided by Arthur D. Little, Inc., and Temple, Barker, and Sloane, Inc.

Manufacturing plants making ethanolamines are estimated to encounter impacts of about 0.45% annually. This implies an annual cost for the average plant of about $50,000. Fluoromethane producers will probably incur negligible costs.

Acrylonitrile producers are expected to incur an annual cost as a percent of value added of about 1.25%. The total annual cost is projected to be about $2 million or $345,000 per plant.

The impact on chloromethane/perchloroethylene producers is likely to be in the range of 0.1%-0.2% of value added. Ethylene dichloride/vinyl chloride producers are also expected to encounter mild impacts in the range of 0.1%-0.2% of value added.

(2) Economic Impact

Table F-36 shows the economic impact of the ISS on the organic chemical industry.

Maleic anhydride, methyl methacrylate, nitrobenzene, and ethanolamine plants are likely to raise prices in response to cost increases imposed by the regulations. No other impacts are expected for these segments.

The high and uneven impact of the regulations on toluene diisocyanate plants makes a plant closure in this segment probable (chance 51-75%). Job losses are possible because all laid-off workers may not be absorbed by the rest of the industry. The remaining firms are likely to raise prices but demand is not expected to be affected. Existing capacity will permit the remaining U.S. producers to fill required demand.

Furfural producers face threats of product substitution and imports to a greater extent than do the producers of other organic chemicals under analysis here. For this reason, they are unlikely (chance of 11-25%) to raise prices to cover the cost of the regulations. As a result, there is a negligible chance (0.5-10%) of a plant closure.

Benzylchloride plants will be unevenly affected by RCRA ISS; the operating rate in this industry segment is about 60%. With only four plants in this segment and an anticipated growth in real demand of about 6% through 1983, the chance of a plant closure is negligible. Nevertheless, customers face the possibility of price increases.

The relatively high cost of the regulation coupled with a declining growth rate for lead alkyl plants make plant closures in this segment possible (chance of occurrence 26-50%). Since workers in complexes may be absorbed by other producing plants, job losses are expected to be negligible (chance 0.5-10%). Price increases by the remaining plants are likely (chance greater than 75%). There is only a negligible chance that U.S. demand will be affected by the price increases.

The uneven cost impact of the ISS on chlorobenzene plants, along with a very low operating rate (about 45%), makes plant closures in this segment likely (chance

TABLE F-36

ECONOMIC IMPACT ON THE ORGANIC CHEMICAL INDUSTRY

Industry Segment	Number of Existing Plants In 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Nitrobenzene* (SIC 2861)	7	none	none	none	likely	none	none
Toluene Diisocyanate (SIC 2865)	10	probable	possible	none	likely	none	none
Furfural (SIC 2865)	5	negligible	none	none	unlikely	none	none
Benzylchloride* (SIC 2865)	4	negligible	none	none	possible	none	none
Lead Alkyls* (SIC 2869)	6	possible	negligible	negligible	likely	negligible	none
Maleic Anhydride* (SIC 2869)	10	none	none	none	likely	none	none
Methyl Methacrylate* (SIC 2869)	4	none	none	none	likely	none	none
Chlorobenzene (SIC 2869)	6	likely	possible	none	likely	none	none
Epichlorohydrin (SIC 2869)	3	none	none	none	negligible	none	none
Ethanolamines* (SIC 2869)	5	none	none	none	likely	none	none
Fluoromethanes* (SIC 2869)	10	none	none	none	negligible	none	none
Acrylonitrile (SIC 2869)	6	0	0	0.1-0.2%	0.4-0.9%	0.1-0.2%	none
Chloromethanes and* Perchloroethylene (SIC 2869)	19	0	0	0.0-0.04%	0.0-0.1%	0.0-0.04%	none
Ethylene Dichloride and Vinyl Chloride Monomer (SIC 2869)	20	0	0	0.0-0.03%	0.0-0.1%	0.0-0.03%	none

Sources: Temple, Barker and Sloane, Inc., (quantitative) and Arthur D. Little, Inc., (qualitative) estimates. The Temple, Barker and Sloane, Inc. quantitative impacts were based on incremental costs generated by Arthur D. Little, Inc., December 1980, which were slightly higher than those shown in Table F-35.

greater than 75%). Job losses are considered possible because all plant employees cannot be absorbed elsewhere in the industry. Price increases by the remaining plants are likely but no production cutbacks or demand reduction are expected.

Minor perturbations in price may be seen in the epichlorohydrin and fluoromethane segments. Aside from this, no impacts on these segments are expected.

Price increases up to about 1% are expected in the acrylonitrile segment, while production cutbacks and demand reduction will probably be minimal. No plant closures or job losses are expected.

Minimal impacts are expected on the producers of chloromethanes/perchloroethylene or ethylene dichloride/vinyl chloride monomer the relatively small price increases and demand reduction will lead to little, if any, cutback in domestic production. Therefore, no plants are expected to close and employment will be unaffected.

Essentially no impact on the balance of payments is expected in the segments of the organic chemical industry analyzed here.

10. THE PESTICIDE INDUSTRY (SIC 28694, 2879)

a. Characterization of the Pesticide Industry

(1) Industry Description

The pesticide industry is composed of the companies that produce the basic toxicants (active ingredients) and the companies that formulate and package the active ingredients with diluents, emulsifiers, and wetting agents. Many producers of the basic toxicants are also formulators, but there also are a number of independent formulators, including large farm cooperatives. The active ingredients for pesticides are primarily synthetic organic chemicals (SIC 28694) included in SIC 2869 — Industrial Organic Chemicals, N.E.C. (not elsewhere classified). The formulators and packagers of pesticide products are classified in SIC 2879 — Agricultural Chemical Products, N.E.C. Although pesticide formulators and packagers generate very little hazardous waste, the producers of the active ingredients generate a relatively large volume of waste.

There are three major types of pesticide products: herbicides, insecticides, and fungicides, as well as minor products like plant growth regulators, seed disinfectants, and fumigants. The producers of the basic active ingredients are increasingly integrating forward by acquiring independent formulators. These producers, for the most part, are large chemical companies with the financial resources to support costly R&D programs and new product registration procedures, and to defend existing products as required by regulatory agencies.

In 1978, the pesticide industry produced approximately 645,000 metric tons of active ingredients at an estimated value of roughly $3.2 billion. The formulated products portion of the pesticide industry (excluding the $3.2 billion of active ingredients) was an estimated 1.6 million MT, valued at about $3 billion. These two segments, added together, represented total pesticide product sales of $6.2 billion in 1978.

(2) Segmentation

This study analyzes the pesticide industry as two separate entities: the active ingredients producing segment (SIC 28694) and the formulating and packaging segment (SIC 2879). Hereafter the latter segment is identified as formulators or Agricultural Chemicals, N.E.C. (formulators).

(3) Structure

While there are no published data for the active ingredients segment, the four-firm concentration ratio is estimated at 30-40%. The four-firm concentration ratio for the formulators segment is approximately 40% (Table F-37).

(4) Supply and Demand

Unit demand is expected to grow 2-2.5%/year through 1983. Capacity utilization is 80%, which is at the low end of the preferred range in both segments; therefore, no supply constraints are expected over the next several years. The elasticity of demand and degree of product substitution vary from low to moderate, depending on the proprietary position of the product and/or the specificity of its end use. Imports are insignificant, representing no more than 3-5% of U.S. pesticide consumption.

(5) Profitability

There are no published profitability data for the active ingredients segment. Formulators' profitability has been declining since 1974. In 1978, net income after taxes as a percent of sales was estimated to be 3.7% (Table F-38). Net income after taxes as a percent of value added was estimated at 8.4%.

(6) Capital Investment

In 1977, formulators' new capital expenditures were $219 million while producers of active ingredients are estimated to have spent $330 million.

b. Economic Impact on the Pesticide Industry

(1) Cost of Compliance

Table F-39 shows the estimated incremental annual cost of compliance with the ISS. Since manufacturers of active ingredients produce most of the hazardous waste in the pesticide industry, it is understandable that they are likely to incur a higher cost of compliance than the formulators. Capital costs for the producers of

TABLE F-37

ECONOMIC CHARACTERIZATION OF THE PESTICIDE INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio (%)	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Active Ingredients (SIC 28694)	3,250.0 38.0[a]	645	80	100	120	30-40	2-2.5	low to moderate[a]	low to moderate[b]	low
Formulators (Agricultural Chemicals N.E.C. SIC 2879)	3,018.0 45.0[a]	1,612.5	80	300	410	40	2-2.5	low to moderate[b]	low to moderate[b]	low

a. Value added as a percent of production value.

b. Depends on proprietary position of product and/or the specificity of its end use.

Sources: Arthur D. Little, Inc., estimates based on U. S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977 Preliminary Report; International Trade Commission, Synthetic Organic Chemicals 1978, published in 1979.

TABLE F-38

FINANCIAL PROFILE OF THE PESTICIDE INDUSTRY

(1972-1978)

SIC 28694: Active Ingredient Segment	1978		1977	1976	1975	1974	1973	1972
Profitability (Organic Chemicals SIC 286)[a]								
Net Income After Taxes/Net Sales (%)			4.0	5.0	4.6	4.9	4.1	3.0
Net Income After Taxes/Net Worth (%)			13.0	16.0	15.0	18.0	12.0	8.0
Revenues (Synthetic Organic Chemicals)[b]								
Value of Shipments ($ Million)			2,808.0	2,410.0	2,366.0	1,816.0	1,344.0	1,092.0
Value Added/Shipments (%)			42.7	44.2	45.2	48.2	51.3	52.3
New Capital Expenditures ($ Million)[c]			332.6	251.9	238.2	149.0	100.3	78.2
SIC 2879: Agricultural Chemicals, N.E.C.								
Profitability[d]								
Net Income After Taxes/Net Sales (%)		upper quartile	8.4	6.0	10.1	8.3	5.8	4.2
	3.7	median	4.1	3.5	6.6	5.2	3.7	2.5
		lower quartile	2.1	1.8	4.4	2.1	2.6	1.7
Net Income After Taxes/Net Worth (%)		upper quartile	20.0	18.8	26.2	28.4	20.9	11.1
	12.9	median	12.7	13.1	21.6	18.5	16.2	6.8
		lower quartile	4.5	5.9	15.4	11.7	9.1	4.5
Revenues[e]								
Value of Shipments ($ Million)	3,018.0		2,787.0	2,755.2	2,290.9	1,974.8	1,325.9	1,150.8
Value Added/Shipments (%)	45.0		47.3	50.3	54.1	57.9	55.8	52.0
New Capital Expenditures ($ Million)			219.2	188.4	207.2	96.9	54.2	39.5

Sources: [a] Arthur D. Little, Inc. estimates based on Robert Morris Associates Annual Statement Studies, 1972-1977. There are no published data for Active Ingredients (SIC 28694).

[b] Value of shipments data from the International Trade Commission, Pesticides and Related Products. Value added/shipments (%) assumed to be comparable to Organic Chemicals (SIC 286).

[c] Arthur D. Little, Inc., estimates.

[d] Dun and Bradstreet, Ratios of Manufacturing, 1973-1977.

[e] U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1972 and 1977, and Annual Survey of Manufactures 1973-1976.

TABLE F-39

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE PESTICIDE INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Active Ingredients (SIC 28694)	1,235.00	6.89	1.99	6.51	1.77	4.11	21.29	23.78	1.92
Formulators (Agricultural Chemicals N.E.C.) (SIC 2879)	1,360.00	2.11	1.16	2.21	0.47	0.29	6.25	5.89	0.43

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

active ingredients are expected to average almost $7 million or almost $60,000 per plant in the first year. Large plants with surface impoundments could incur annual costs of about $400,000, which could amount to almost 2% of value added. Small plants with surface impoundments could encounter costs in excess of 10% of value added.

On the other hand, formulators' first-year capital costs are expected to average roughly $5000 per plant. Only a few small plants with surface impoundments may experience annual costs that are more than 2% of value added.

(2) Economic Impact

Both segments of the pesticide industry are likely (chance of occurrence greater than 75%) to raise prices to attempt to cover the cost of the regulations. In the case of formulators, this is the only significant impact expected because the regulations do not impose substantial costs on the plants in this segment. Plant closures and job losses are unlikely (chance 11-25%). There is a negligible chance of production cutbacks because capacity is likely to be adequate to meet demand even if closures occur (Table F-40).

Process unit and/or plant closures are likely, however, in the active ingredients segment. If a process unit closes, some employees may be absorbed but when a plant closes most of the employees can be expected to lose their jobs. Thus, job losses in the active ingredients segment are considered probable (chance 51-75%). Because capacity is available, U.S. production cutbacks are expected to be negligible. There is also a negligible chance that imports of active ingredients may increase.

11. THE COMMERCIAL EXPLOSIVES INDUSTRY (SIC 2892)

a. Characterization of the Commercial Explosives Industry

(1) Industry Description

The commercial explosives industry produces a large variety of explosive items for use in coal, metal, and nonmetal mining and in the quarrying and construction industries. This study excludes all explosives manufactured in government-owned/company-operated or government-owned/government-operated plants. The principal commercial explosives characterized under SIC 2892, in order of volume produced, are unprocessed ammonium nitrate blasting agents, ammonium nitrate fuel-mixed blasting agents, water gels and slurries, and high explosives (including permissibles). Permissibles are a classification of explosive types approved by the U.S. Bureau of Mines for use in underground coal mines.

In 1978, the industry produced approximately 1.69 million metric tons of blasting agents and 100,000 MT of high explosives.

TABLE F-40

ECONOMIC IMPACT ON THE PESTICIDE INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Active Ingredients (SIC 28694)	120	likely[a]	probable	negligible	likely	negligible	negligible
Formulators (Agricultural Chemicals, N.E.C.) (SIC 2879)	410	unlikely	unlikely	negligible	likely	negligible	none

[a] Mainly process units rather than plants.

Source: Arthur D. Little, Inc., estimates.

(2) Segmentation

This study analyzes the commercial explosives industry as two segments: blasting agents and high explosives. Blasting agents have a much lower degree of sensitivity to detonation than do high explosives. For this reason, blasting agents can be handled and shipped like chemicals but high explosives must be handled much more carefully under a complex protocol.

(3) Structure

The four-firm concentration ratio of the blasting agents segment of the commercial explosives industry is estimated to be 60-70%; for the high explosives segment it is 85-90% (see Table F-41).

(4) Supply and Demand

Unit demand from 1978 to 1983 is forecast to grow 7.5%/year for blasting agents and 4.0%/year for high explosives. The gradual phase-out of dynamite is causing the slower growth of the high explosives segment. Dynamite is being phased out in favor of blasting agents because of its explosive tendency and its toxic properties (it contains nitroglycerin). Capacity utilization is at the low end of the preferred range. No supply constraints are expected over the next several years.

(5) Profitability

There are no published data on the profitability of the commercial explosives industry. Net income after taxes as a percentage of sales is estimated to be approximately 4% (Table F-42), while net income after taxes as a percentage of value added is estimated at 7% (Table F-43).

(6) Capital Investment

Capital expenditures for explosives increased modestly from $14.9 million in 1972 to $26.1 million in 1977.

b. Economic Impact on the Commercial Explosives Industry

(1) Cost of Compliance

Table F-44 shows that the estimated incremental annual cost of compliance with the ISS is about $700,000 for the high explosives segment and $6.2 million for the blasting agents segment. This annual cost as a percent of value added is 2.5% for high explosives and almost 1.5% for blasting agents.

In the high explosives segment, the first-year capital cost and the closure fund costs together comprise almost 90% of total first-year costs at about $690,000, or an average of more than $46,000 per plant. The capital costs and closure fund costs for the blasting agents segment are more than 90% of first-year costs at about $5.7 million or about $70,000 per plant.

TABLE F-41

ECONOMIC CHARACTERIZATION OF THE COMMERCIAL EXPLOSIVES INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Blasting Agents (SIC 2892)	720.0 57.0[a]	1,682	80	20	80	60-70	7.5	low	low	low
High Explosives (SIC 2892)	50.0 58.0[a]	100	80	5	15	80-90	4.0	low	low	low

a. Value added as a percent of production value.

Source: Arthur D. Little, Inc., estimates based on U.S. Department of Interior, Bureau of Mines, U.S. Mineral Industrial Surveys Bulletin.

TABLE F-42

FINANCIAL PROFILE OF THE COMMERCIAL EXPLOSIVES INDUSTRY

(1972-1977)

Total Industry (SIC 2892)	1977	1976	1975	1974	1973	1972
Profitability						
Net Income After Taxes/Net Sales (%)	← 4% →					
Revenues[a]						
Value of Shipments ($ Million)	666.3	602.6	613.0	548.2	429.4	408.7
Value Added/Shipments (%)	57.0	61.5	58.9	68.4	70.3	69.8
New Capital Expenditures ($ Million)	26.1	17.5	22.4	20.6	12.5	14.9

Sources: a. U. S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1972 and 1977 and Annual Survey of Manufactures 1973-1976.

TABLE F-43

FINANCIAL PROFILE OF THE COMMERCIAL EXPLOSIVES INDUSTRY BY SEGMENT
(1978)

	Blasting Agents (SIC 2892)	Fixed High Explosives (SIC 2892)
Profitability		
Net Income After Taxes/Net Sales (%)	4.0	4.0
Net Income After Taxes/Net Worth (%)	N/A	N/A
Net Income After Tax/Value Added (%)	7.0	7.0
Revenues		
Value of Shipments ($ Million)	720.0	60.0
Value Added/Shipments (%)	57.0	58.0

Source: Arthur D. Little, Inc., estimates.

TABLE F-44

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE COMMERCIAL EXPLOSIVES INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Blasting Agents (SIC 2892)	410.00	2.73	0.15	2.94	0.24	0.00	6.08	6.21	1.52
High Explosives (SIC 2892)	29.00	0.39	0.03	0.30	0.05	0.00	0.78	0.71	2.48

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

(2) Economic Impact

The relatively slow growth of the high explosives industry, coupled with the substantial first-year capital and closure fund costs required by RCRA, makes closure of a small plant in this segment possible (chance of occurrence 26-40%). The larger plants, which generally also provide consulting services to coal companies concerning the use of underground explosives, are expected to continue operating. Job losses are also considered possible in the high explosives segment. The remaining firms in this segment are likely to raise prices (chance greater than 75%) to cover the cost of RCRA (Table F-45).

Plant closures are also considered possible in the blasting agents segment. These closures may occur because of the high first-year capital and closure fund costs required by the regulations. Job losses are unlikely (chance 11-25%) because firms phasing out the production of explosives may become distributors. Price increases to cover RCRA's costs are likely to be instituted by manufacturers of blasting agents. As Table F-45 shows, no production cutbacks, demand reduction, or balance of payments effects are anticipated in either segment.

12. THE PETROLEUM REFINING INDUSTRY (SIC 2911)

a. Characterization of the Petroleum Refining Industry

(1) Industry Description

In 1978 the petroleum refining industry was composed of 179 firms and 285 refineries, ranging in capacity from less than 1000 barrels/day to more than 600,000 barrels/day. Because most refineries are located near domestic crude oil production or ports receiving shipments of foreign crude and unfinished oils, or are connected by pipeline to these locations, refining capacity is concentrated in the Gulf Coast, West Coast, Mid-Atlantic, and Midwest regions.

Refineries belong to major oil companies or to independent regional refiners. Major oil companies operate several refineries, whereas independent refiners may operate only one. The industry employs more than 160,000 people.

Petroleum refineries vary from fully integrated, highly complex plants capable of producing a complete range of petroleum products and some petrochemicals to very simple plants capable of producing only a small number of products. In general, refinery complexity increases with crude capacity (size).

(2) Segmentation

This study divides the petroleum refining industry into three segments as follows: small, less than 35,000 barrels/day; medium, 35,000-99,000; and large, more than 100,000.

TABLE F-45

ECONOMIC IMPACT ON THE COMMERCIAL EXPLOSIVES INDUSTRY

Industry Segment (SIC 2892)	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Blasting Agents-Explosives	80	possible	unlikely	none	likely	none	none
High Explosives	15	possible	possible	none	likely	none	none

Source: Arthur D. Little, Inc., estimates.

(3) Structure

The largest companies dominate the petroleum refining industry. The four largest refiners, all major oil companies, operate 12 refineries and control 32% of the industry's capacity (Table F-46).

(4) Supply and Demand

Product demand is expected to decline an average 1%/year during 1978-1983. Overall growth in petroleum consumption began to decline in 1979* because of conservation of energy and a slower growth in gasoline demand. Such government actions as decontrol of domestic crude oil prices will further depress demand. In addition, as utilities convert to coal, even less oil will be required.

(5) Profitability

Industry profit margins recovered in 1977, having declined after the oil embargo of 1973-1974, as imported crude prices have steadily risen (Table F-47). In 1978, net income as a percentage of sales was 2.1% (Table F-48), which in part reflects the rapid rise in raw material cost. The Federal government has continued to protect small refiners from increasing foreign crude prices through its entitlements program. The small-refiner bias will go out of existence with crude oil decontrol.

The near-term outlook in petroleum refining is not as favorable as in the recent past. Low utilization of capacity and uncertainty about possible legislation to protect the domestic industry from foreign competition after crude oil price decontrol lead many observers** to take a pessimistic view of short-term market conditions and profit margins. In fact, some small refinery closings are anticipated. Due to the low profit margins created by this situation, it is uncertain whether the industry can recover increased nonproduction costs in the marketplace.

(6) Capital Investment

Petroleum refining is highly capital-intensive. Significant new capital expenditures will be required as refiners install capacity to handle heavy sour (high-sulfur) crude, particularly for upgrading the residual fractions produced from these crudes. These capital expenditures are running 25-50% of total capital expenditures in the industry.

b. Economic Impact on the Petroleum Refining Industry

(1) Cost of Compliance

Table F-49 shows that the estimated incremental annual cost of compliance with the ISS is about $79 million. This cost averages about 0.5% of value added for

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**Oil and Gas Journal*, "Mid-Year Report," pp. 162-168, July 28, 1980.

***Wall Street Journal*, page 1 of Section 2, November 21, 1980.

TABLE F-46

ECONOMIC CHARACTERIZATION OF THE PETROLEUM REFINING INDUSTRY

Industry Segment (SIC 2911)	1978 Production Value ($ Million)	1978 Production (MB/D)[c]	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio (%)	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Small < 35 MB/D[c]	10,166 7.6[a]	1,708	88.5	–	162	–	–	–	–	high
Medium 35-99 MB/D[c]	21,114 15.3	3,232	88.5	–	66	–	–	–	–	–
Large > 100 MB/D[c]	65,320 17.8	9,802	88.5	–	57	–	–	–	–	–
Total	96,606 16.2	14,742	88.5	179	285	0.32[b]	-1.0%	low	moderate	moderate

a. Value added as a percent of production value.

b. 35 plants with total crude capacity of 5.4 million barrels/day.

c. MB/D = thousands of barrels per day.

Sources: Arthur D. Little, Inc., estimates based on *Oil and Gas Journal* March 24, 1980, pp. 130-157.

TABLE F-47

FINANCIAL PROFILE OF THE PETROLEUM REFINING INDUSTRY
(1972-1977)

Total Industry (SIC 2911)	1977	1976	1975	1974	1973	1972
Profitability[a]						
Net Income After Taxes/Net Sales (%)	5.97	3.13	4.19	6.12	7.03	5.03
Net Income After Taxes/Net Worth (%)	14.65	16.94	15.10	17.53	14.37	9.99
Revenues[b,c]						
Value of Shipments ($ Million)	91,833[c]	77,507.3	65,254.2	54,833.8	31,845.8	26,921.1
Value Added/Shipments (%)	15.54	14.72	13.68	15.25	20.48	17.72
New Capital Expenditures ($ Million)[c]	2,162.9	2,531.1	2,275.2	1,718.3	1,012.5	1,081.8

Sources:
a. Dun and Bradstreet, Ratios of Manufacturing, 1973-1976.
b. U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1972 and Annual Survey of Manufactures, 1973-1976.
c. U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977.

TABLE F-48

FINANCIAL PROFILE OF THE PETROLEUM REFINING INDUSTRY BY SEGMENT
(1978)

Total Industry (SIC 2911)	Segment: < 35 MBD	Segment: 35-99 MBD	Segment: > 100 MBD	Total
Profitability[a]				
Net Income After Taxes/Net Sales (%)	–	–	–	2.12
Net Income After Taxes/Net Worth (%)	–	–	–	15.88
Net Income After Tax/Value Added (%)	–	–	–	–
Revenues[b]				
Value of Shipments ($ Million)	10,166	21,119	65,320	96,605
Value Added/Shipments (%)	758 (7.5)	3,230 (15.3)	11,652 (17.8)	15,640 (16.2)
New Capital Expenditures ($ Million)	–	–	–	2,163

Sources: a. Dun and Bradstreet. *Ratios of Manufacturing.* Due to the increase in the number of smaller companies in the 1978 sample, comparisons with past years' ratios are invalid.

b. Arthur D. Little, Inc., estimates.

c. MBD = thousands of barrels per day.

TABLE F-40

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE PETROLEUM REFINING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Petroleum Refining (SIC 2911)	14,274.20	19.41	13.64	21.54	5.39	13.94	73.94	78.99	0.55

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1914.

Source: Arthur D. Little, Inc., estimates.

the petroleum refining industry. The impacts range from about 1% for small plants with surface impoundments to about 0.2% for large firms without surface impoundments.

First-year costs for the industry are estimated at about $74 million. A large plant with surface impoundments could incur a cost of more than $1 million annually. However, this cost is expected to amount to less than 1% of value added.

(2) Economic Impact

Table F-50 shows that small plants are expected to experience greater adverse impacts after the promulgation of the ISS than medium to large plants. All plants are likely (chance of occurrence greater than 75%) to raise prices in an attempt to cover the cost of the regulations. If the market for petroleum products is soft at the time the regulations are implemented, price increases may be delayed until demand firms up.

Plant closures and job losses are considered unlikely (chance 11-25%) for small plants, negligible (chance 0.5-10%) for medium-sized plants, and none for large plants.

No reduction in demand, production cutbacks, or balance of payments effects are expected.

13. THE PETROLEUM REREFINING INDUSTRY (SIC 2992)

a. Characterization of the Petroleum Rerefining Industry

(1) Industry Description

The rerefining of waste oil produces high quality lubricating oil base stocks, which are used in motor oils, gear oils, transmission fluids, hydraulic oils, machine oils, and metal cutting oils. In addition, rerefined oil is sold as blending stock to other oil blenders who market a finished product.

Most of the 23 operating rerefiners are small, old, family-run businesses. Most of the waste oil is used motor oil gathered from service stations, garages, car dealers, and truck, bus, and auto fleets. Some rerefiners have a closed or semi-closed loop arrangement whereby the source of the waste oil, e.g., an industrial plant, may also be a customer for rerefined oil.

Most companies employ between 6 and 25 workers. Facilities are generally more than 15 years old, although a few plants have been modernized within the last 5 years. Most rerefiners are expanding into other nonrerefining areas because of low profits from rerefining activities.

TABLE F-50

ECONOMIC IMPACT ON THE PETROLEUM REFINING INDUSTRY

Industry Segment (SIC 2911)	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases[b]	U.S. Demand Reduction	Balance of Payments Effects
Small <35 MB/D[a]	162	unlikely	unlikely	none	likely	none	none
Medium 35-99 MB/D	66	negligible	negligible	none	likely	none	none
Large >100 MB/D	57	none	none	none	likely	none	none

[a] MB/D = Thousands of barrels per day

[b] Depending on the timing of the ISS, market conditions may delay price increases.

Source: Arthur D. Little, Inc., estimates.

(2) Segmentation

The petroleum rerefining industry has been analyzed as a single industry segment.

(3) Structure

Only 23 rerefining plants have survived from a total of more than 165 operating in the early 1960s (Table F-51). The contraction of this industry is the result of many institutional and marketing problems. The attrition has fostered a significant concentration, with the top four rerefiners marketing about 60% of the rerefined oil volume in 1978. This industry rerefines 75 million gallons of oil annually out of a total sales pool of more than 2 billion gallons of virgin oil.

(4) Supply and Demand

Despite past problems, the rerefining industry has potential because it (1) helps keep the environment clean of waste oil; and (2) promotes the conservation of scarce hydrocarbons.

The growth rate of the rerefining industry is highly dependent upon future government regulatory action to ensure the availability of waste oil feedstock and to promote the use of rerefined oil by changes in Federal specifications and labeling requirements. New Department of Defense lubricating oil specifications that allow sale of rerefined oil to military and governmental units have been developed. If these new specifications become effective, they will open new markets for rerefined oil and provide product specifications that can be used in the private sector to evaluate rerefined oil. Under these favorable circumstances, which are not expected to occur until after 1983, the rerefining industry could experience a growth rate of 15%/year. In the meantime, the growth in quantity sold is expected to remain at a sluggish 2%/year. If the Federal specifications were changed so that demand for rerefined oil began to increase, the hazardous waste regulations would benefit the industry because they would significantly increase the feedstock available to rerefiners. This increase in supply would make a high growth rate for the industry possible.

At present, the depressed market for rerefined oils has resulted in only a 55% utilization of U.S. rerefining capacity.

Rerefiners are still expecting that conditions will improve. One new rerefining plant with a capacity of about 12-15 million gallons/year has recently been constructed in Michigan, and several expansions with a total new capacity of 5-8 million gallons annually have been or will soon be completed. Rerefiners are holding on through the lean years by increasing their custom rerefining business. This business is concentrated in such highly industrial areas of the midwest as Detroit and Cleveland, and in Los Angeles, because of the concentration of aerospace companies there. In these areas, there is a large demand for rerefined industrial lubricants and cutting oils.

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TABLE F-51

ECONOMIC CHARACTERIZATION OF THE PETROLEUM REREFINING INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)[a]	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Petroleum Rerefining (SIC 2992)	56.3 46[b]	255	55	20	23	60	2	moderate	moderate	none

a. Equivalent to 75 million U.S. gallons.

b. Value added as a percent of production value.

Source: Arthur D. Little, Inc., estimates.

The elasticity of demand for rerefined oils is moderate because the upper limit is set by the cost of virgin oils less a virgin oil premium of approximately 15 cents/gallon. A key problem in the rerefining industry is the rerefiners' inability to compete for waste oil feedstock, which is mostly being siphoned off as a fuel oil extender at a higher price than most rerefiners can reasonably pay.

There is no import competition in the rerefined oil business.

(5) Profitability

When rerefining operations are viewed as separate profit centers, the average rerefiner has negative net margins with a positive cash flow provided only by a "set aside" for depreciation. The key factor here is that the price of street drainings, i.e., waste oil feedstocks, has been bid up to 15-22 cents/gallon by fuel oil resellers for blending into 32 cents/gallon fuel oil. Only 5 years ago rerefiners in many areas were paid 5 cents/gallon to cart away the waste oil. Furthermore, plant labor expenses have increased much faster than the rerefiner's gross margin. Net income after taxes as a percent of sales has been decreasing since 1972 and net income after taxes as a percent of value added is estimated to be a negative 2% in 1978 (Table F-52).

(6) Capital Investment

The rerefining industry is not significantly capital-intensive, since most of the existing facilities have already been depreciated. However, a new rerefining plant to treat 5-10 million gallons/year would probably require an investment of approximately $2.5-4.0 million, or about five times current average net fixed assets in most rerefining operations. A substantial part of this investment would be for pollution control equipment to handle waste streams generated by the plant.

b. Economic Impact on the Petroleum Rerefining Industry

(1) Cost of Compliance

Table F-53 shows that the estimated incremental annual cost of compliance with the ISS is almost $3 million. This annual cost as a percent of value added in the rerefining industry is about 11%.

The first-year capital cost of the regulations is $1.6 million or almost $70,000 per plant. Small rerefining plants will be hardest hit. They are expected to incur costs of about 15% of their value added, while the cost for large plants could be less than 8% of their value added.

(2) Economic Impact

Table F-54 shows that it is likely (chance of occurrence greater than 75%) that plant closures and job losses will occur in the petroleum rerefining industry. The high cost of the regulations, coupled with the low profitability of the industry, makes the burden on this industry very significant.

TABLE F-52

FINANCIAL PROFILE OF THE PETROLEUM REREFINING INDUSTRY
(1972-1978)

	1978	1977	1976	1975	1974	1973	1972
Profitability							
Net Income After Taxes/Net Sales (%)	(1%)	←				decreasing	
Net Income After Taxes/Net Worth[a] (%)	(3%)	←				decreasing	
Net Income After Tax/Value Added (%)	(2%)	←				decreasing	
Sales							
Total Sales ($ Million)	56.3	40.0 ←		static			
Value Added/Sales (%)	46.0	50.0 ←				decreasing	
New Capital Expenditures	←			insignificant expenditures on a net basis			

a. Only staying in business because getting cash from depreciation.

Source: Arthur D. Little, Inc., estimates.

TABLE F-53

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE PETROLEUM REREFINING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Petroleum Rerefining (SIC 2992)	26.00	1.63	0.60	0.87	0.30	0.17	3.59	2.82	10.85

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-54

ECONOMIC IMPACT ON THE PETROLEUM REREFINING INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Petroleum Rerefining (SIC 2992)	23	likely	likely	possible	likely	possible	none

Source: Arthur D. Little, Inc., estimates.

The remaining plants in the industry will attempt to raise prices to cover the cost of the regulations. Since substitute products are available, a price increase could cause a reduction in the quantity demanded (chance 26-50%). If demand drops, a parallel reduction in production would be expected.

The rerefining industry now has a large excess capacity. As a result, production lost through closing some plants may be made up by the remaining firms in the industry if demand for rerefined oil is not reduced by the RCRA-induced price increases.

14. THE RUBBER PRODUCTS INDUSTRY (SIC 3011, 3021, 3031, 3041, 3069)

a. Characterization of the Rubber Products Industry

(1) Industry Description

The rubber products industry has five separate segments: tires and inner tubes (SIC 3011); rubber and plastic footwear (SIC 3021); reclaimed rubber (SIC 3031); hose and belting (SIC 3041); and fabricated rubber products N.E.C. (SIC 3069). The tire and inner tube segment represents approximately 60% of the shipment value of the segment in SIC 30. The market for bias ply and bias belted tires is declining, with resulting overcapacity. The impact of imports of radial tires is not great now, except as components of foreign cars, but is growing. In 1978, tires imported on new foreign cars amounted to 5-6% of new tire consumption and may reach 8-10% in 1980. On the other hand, foreign competition for bicycle tires, inner tubes, and automobile inner tubes is quite intense.

The U.S. rubber and plastic footwear industry has been slowly declining because it is highly labor-intensive, and cannot meet foreign competition, especially for the low-priced segment of the U.S. market. Foreign imports have penetrated 3-70% of the U.S. footwear market, depending on the type.

The shipment value of the other three segments, i.e., reclaimed rubber, hose and belting, and fabricated rubber products, has increased approximately 50% overall since 1972.

(2) Segmentation

This study analyzes the rubber products industry as two entities: the tire and inner tube segment; and the combined segments of footwear, reclaimed rubber, rubber hose and belting, and fabricated rubber products.

(3) Structure

There are about 75 tire and inner tube manufacturers, with the four largest companies accounting for approximately 75% of industry shipment value. The concentration ratio for reclaimed rubber is about 75%. The footwear segment is somewhat less concentrated, with the four largest companies accounting for 60% of industry shipment value. About 60 companies manufacture hose and belting, with the top four companies representing more than 50% of industry shipment value. Fabricated rubber products is the least concentrated of the four segments, with the four largest companies accounting for only 16% of industry shipment value (Table F-55).

(4) Supply and Demand

Overall growth in unit demand for tires and inner tubes will be approximately 0-2%/year from 1978 to 1983. The growth in shipment value, however, will average 2-3% (excluding inflationary price changes) because of the conversion to higher-unit-value radial tires from bias ply tires in the passenger car, truck, and bus tire replacement markets. Hose and belting shipment value is expected to grow at an average annual rate of 3-4% (excluding inflationary price change) because of the effect of automotive clean air regulations and the increasing use of agricultural irrigation systems, which will require increased usage of hose and belting. There is little chance that footwear will achieve any economic growth in the future because the ratio of foreign imports to domestic manufactured footwear is expected to increase somewhat further to supply a U.S. unit demand increase of approximately 1.5-2%/year. The value of shipments of fabricated rubber products will not change through 1983, except for the effects of inflation, because of the increasing substitution of plastic for rubber.

(5) Profitability

After-tax profit margins for the rubber industry as a whole declined from a high of 5.5% in 1973 to 2.9% in 1978 (Table F-56). No published information is available on the profitability of individual segments. In the period 1979-80, however, several U.S. companies abandoned tire manufacture altogether and permanently closed many plants, an unmistakable indication of the weak financial position of the domestic tire industry. The tire operations of major participants, e.g., Firestone and Uniroyal, have been very unprofitable. For the first time in modern history, no passenger tire plants are operating in Akron, Ohio, the capital of the rubber industry. A general situation of overcapacity, moderate to intense foreign competition, and an uncompetitive cost position relative to foreign imports is expected to keep industry profitability low. Furthermore, the industry still has a large investment in old rubber processing plants, which means new facilities are unlikely to be built. Also, the rate of technological development in plant equipment has been slow. The plastics industry, with modern plants, continues to replace rubber products with plastic equivalents.

(6) Capital Investment

New capital expenditures for rubber products as a whole have declined an average of 8%/year since 1973 in current dollars and at a much faster rate in constant dollars.

TABLE F-55

ECONOMIC CHARACTERIZATION OF THE RUBBER PRODUCTS INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Tires and Inner Tubes (SIC 3011)	10,650 48[a]	3,320	80	75	210	75	0-2.0	moderate	low	moderate
Other Rubber Products: (Footwear, Hose and Belting, Reclaimed and Fabricated Rubber Products) (SIC 3021, 3031, 3041, 3069)	7,000 52[a]	1,026	60-85	770	1,500	16-75	0-4.0	high	moderate	high

[a] Value added as a percent of production value.

Sources: Standard & Poor's Industry Surveys, October 27, 1979 and June 28, 1979; U.S. Industrial Outlook, 1978; and Arthur D. Little, Inc., estimates.

TABLE F-56

FINANCIAL PROFILE OF THE RUBBER PRODUCTS INDUSTRY
(1972-1978)

	1978		1977	1976	1975	1974	1973	1972
	Tires and Inner Tubes (SIC 3011)	Other Rubber Products (SIC 3021, 3031, 3041, 3069)	Total Industry					
Profitability[a]								
Net Income After[1] Taxes/Net Sales (%)		2.9	3.5	2.5	3.0	5.0	5.5	4.0
Net Income After Taxes/Net Worth (%)		11	10	12	8	14	12	10
Revenues[2]								
Value of Shipments ($ Million)	10,850	7000	16,142.8	13,552.7	12,353.5	12,677.7	11,415.0	10,198.1
Value Added/Shipments (%)	48.0	52.0	49.5	49.6	50.4	52.8	56.8	55.2
New Capital Expenditures ($ Million)			486.2	542.1	494.1	633.8	684.9	509.9

a. The profitability data are for the other rubber products segment; such data are not available for tires and inner tubes although it is generally acknowledged that the profitability of the tire segment is significantly below that of other rubber products.

Sources: 1. Robert Morris Associates, Annual Statement Studies 1973-1977.
2. U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1972, and Annual Survey of Manufactures 1973-1977.

b. Economic Impact on the Rubber Products Industry

(1) Cost of Compliance

Table F-57 shows the estimated incremental annual cost of compliance with the ISS. The tires and inner tube segment of the rubber products industry is expected to encounter a first-year capital cost of about $6500 per plant and a first-year total cost averaging about $18,500 per plant. Although the total annual cost as a percent of value added is only 0.06%, the first-year costs will be a heavy burden for many plants in the tire industry. Furthermore, small plants with surface impoundments may encounter costs of more than $50,000 annually, which would be close to 1.5% of their value added.

Although the total cost of the regulations is higher for the "other" rubber products segment, the first-year capital cost per plant is only about $1150 and total first-year expenditures per plant are expected to average $6000. Given the lower average cost per plant and the higher profitability of this segment, "other" rubber products can more readily bear the cost of the regulations. Only small plants with surface impoundments are expected to encounter costs that approach 1% of value added.

(2) Economic Impact

Given the financial difficulties of producers of tires and tubes, plant closures and job losses are probable (chance of occurrence 51-75%) (Table F-58). Price increases will be held down by the threat of imports. Excess capacity and slow growth will ensure that U.S. producers can meet the demand for tires and tubes.

Plant closures and job losses are considered negligible (chance 0.5-10%) in the "other" rubber products segment because these companies are under less financial pressure than the tire and tube segment. Some firms may attempt price increases, but competition in the industry will probably keep increases to a minimum. No production cutbacks, demand reduction, or balance of payments effects are expected.

15. THE LEATHER TANNING AND FINISHING INDUSTRY (SIC 3111)

a. Characterization of the Leather Tanning and Finishing Industry

(1) Industry Description

The leather tanning and finishing industry engages in the tanning, currying, and finishing of hides and skins into leather. The size and ownership of firms range from small family operations to divisions of large conglomerates. There is also a wide range of techniques for processing the various hides and skins. Tanneries are concentrated in the Northeast, and more than 70% of the plants are at least 50 years old. Many have been modernized, but technological changes in the last 50 years have been minimal. Shoe manufacturing consumes approximately one-half of all domestic leather. The industry employs 22,000 people, 80% of whom are production employees.

TABLE F-57

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE RUBBER PRODUCTS INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Tires and Inner Tubes (SIC 3011)	5,200.00	1.40	0.89	0.63	0.51	0.44	3.89	3.27	0.06
Other Rubber Products (SIC 3021, 3031, 3041, 3069)	3,600.00	1.74	4.52	0.45	1.41	1.20	9.33	6.58	0.18

a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-58

ECONOMIC IMPACT ON THE RUBBER PRODUCTS INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Tires and Inner Tubes (SIC 3011)	210	probable	probable	none	negligible	none	none
Other Rubber Products (SIC 3021, 3031, 3041, 3069)	1500	negligible	negligible	none	negligible	none	none

Source: Arthur D. Little, Inc., estimates.

(2) Segmentation

The 430 establishments in the industry include wet and dry tanneries that produce hazardous waste as well as leather converters and nonproduction plants that do not. The traditional industry segmentation is by type of leather manufactured, such as cattle hide, sheepskin, etc. For purposes of assessing the impacts of hazardous waste management, however, this study categorizes the industry by type of manufacturing processes; only those firms that use such processes have been included. The seven tannery categories include:

- Chrome tan (cattle) — primarily processes cattle or cattle-like hides into finished leather, using chrome in the tanning process.
- Nonchrome tan (vegetable) — primarily processes cattle or cattle-like hides into finished leather, using vegetable, alum, oils, and other materials and combinations in the tanning process.
- Retan (sides/splits) — processes previously tanned hides and/or skins into finished leather, using a major wet process consisting of retanning, coloring, and fat-liquoring.
- No beamhouse (sheep) — primarily processes hides and/or skins with the hair previously removed into finished leather, using either chrome or nonchrome tanning methods. Includes pickled sheepskins, cattle hides, and pigskins.
- Through-the-blue (cattle) — primarily processes raw or cured cattle or cattle-like hides through the blue-tanned state only. Tanneries have no retanning or finishing operations and use chrome in the tanning process.
- Shearlings — primarily processes raw or cured sheep or sheep-like skins with the wool or hair retained on the hide into finished leather, using chrome or nonchrome tanning methods.
- Leather finishers — receive unfinished leather to which they apply a finish and may also buff to remove imperfections. They do not perform any other tanning functions.

(3) Structure

Except for the cattle hide through-the-blue tanneries, this industry is categorized by relatively low concentration ratios, ranging from 10-50% (Table F-59). The largest segments of the industry are cattle hide chrome and leather finishers.

(4) Supply and Demand

Since mid-1977, the domestic industry has incurred strong competition from foreign tanneries, not only for finished leather in U.S. markets but also for raw

TABLE F-59

ECONOMIC CHARACTERIZATION OF THE LEATHER TANNING AND FINISHING INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production Hide Equivalents[a] (Thousand Hides)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio (%)	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition[b]
Chrome Tan (Cattle)	862 26.2[c]	18,000	85	78	83	25	−2	high	high	high
Nonchrome Tan (Cattle)	99 28.9[a]	2,500	85	14	16	35	−2	high	high	high
Retan (Sides/Splits)	66 25.2[a]	7,000	75	37	37	45	−2	moderate	high	high
No Beamhouse (Sheep)	87 22.0[a]	2,850	75	27	29	50	−2	high	high	high
Through-the-Blue (Cattle)	190 13.2[a]	5,000	85	12	12	60	+5	moderate	low	low
Shearling	32 33.5[a]	750	90	9	9	40	0	high	high	high
Leather Finishers	59 42.4[a]	5,000	75	80	85	10	−4	high	high	high
Converters, Brokers, Sales Offices, Dealers, etc.	–	–	–	143	159		Not directly impacted by RCRA requirements			
Total	1,395 34.7[a]	20,100	80	400	430	22	−2	high	high	high

a. Because of reprocessing among subcategories, totals of subcategories exceed industry total.

b. Tanners face import competition for leather and finished products, They also force high competition for hides being exported.

c. Value added as a percent of production value.

Source: Development Planning and Research Associates, Inc.

hides. Because of this strong competition, the long-range outlook for the U.S. industry is poor. Overall real growth, as measured by unit production, is expected to decline 1.5-2.0% compounded annually from 1978 to 1983.

(5) Profitability

Table F-60 provides financial information on the leather tanning industry as a whole. Tax profit on sales declined in 1976 and 1977, after increasing from 1972 to 1975. Overall profitability increased slightly in 1978. Table F-61 shows the financial information by industry segment for 1978.

(6) Capital Investment

New capital expenditures for the industry increased from 1973 to 1976 and then leveled off.

b. Economic Impact on the Leather Tanning and Finishing Industry

(1) Cost of Compliance

Table F-62 presents the estimated incremental annual cost of compliance with ISS for the subcategories of the leather tanning and finishing industry. For the total industry first-year capital expenditures are estimated to total about $2.4 million or approximately $5500 per plant. First-year one-time expenditures are expected to average about $7000 per plant in the industry as a whole.

With regard to the total annual cost, the industry is estimated to spend almost $24 million annually to comply with ISS. This represents almost 7% of the impacted plants' value added.

(2) Economic Impact

Table F-63 summarizes the economic impacts of ISS compliance for the leather tanning and finishing industry. These impacts were assessed on a model plant basis utilizing a net present value analysis to determine the models' required price increases, their ability to increase prices to offset ISS expenditures, and the potential impacts such as plant closures, job losses, production cutbacks, demand reduction, and balance of payments effects. The impacts presented reflect industry conditions as of 1978 and do not include compliance costs for proposed BATEA and PSES effluent guidelines.

To comply with the ISS the various plants in the industry would use several disposal/treatment methods. These compliance methods and their associated costs vary considerably among plants depending on the plants' processes, their current disposal practices, their respective waste volumes, and the characteristics of their wastes. This analysis considered the impact of each disposal method separately.

TABLE F-60

FINANCIAL PROFILE OF THE LEATHER TANNING AND FINISHING INDUSTRY

(1972-1978)

Total Industry* (SIC 3111)	1978	1977	1976	1975	1974	1973	1972
Profitability[a]							
Net Income After Taxes/Net Sales (%)	1.9	1.1	1.3	3.3	3.0	1.0	1.3
Net Income After Taxes/Net Worth (%)	11.9	9.8	8.0	9.0	6.5	7.0	5.0
Revenues[b]							
Value of Shipments ($ Million)	1663.0	1489.0	1326.0	1091.8	1075.5	1081.5	1059.5
Value Added/Shipments (%)	34.7	36.9	39.3	40.6	37.0	31.0	34.8
New Capital Expenditures[b] ($ Million)	NA	31.8	32.6	22.7	13.1	12.8	16.3

*Includes non-waste producing leather converters, brokers, dealers, warehousers and others.

Sources: [a]Development Planning and Research Associates, Inc. estimates.

[b]U.S. Department of Commerce, Census of Manfactures, 1972 and 1977, Annual Survey of Manufactures, 1972-1976, and Industrial Outlook, 1980.

TABLE F-61

FINANCIAL PROFILE OF THE LEATHER TANNING AND FINISHING INDUSTRY
(1978)

Industry Segment	Allocation of Existing Plants	Annual Net Income After Taxes: Percent of Sales (%)	Annual Net Income After Taxes: Percent of Net Worth (%)	Annual Revenues: Value of Shipments ($ Million)	Annual Revenues: Value Added as Percent of Shipments (%)	Annual New Capital Expenditures ($ Million)
Chrome Tan (cattle)						
X-Small	10	4.3	8.9	9	35.2	0.2
Small	18	4.2	14.5	64	25.9	1.4
Medium	22	3.4	13.1	176	20.0	3.5
Large	19	2.9	8.9	254	20.0	4.3
X-Large	14	4.1	12.4	374	24.7	6.5
Nonchrome Tan (veg)						
Small	6	4.7	6.8	6	44.7	0.1
Medium	6	2.8	6.7	38	24.5	0.5
Large	4	1.3	4.9	58	17.5	0.7
Retan						
Splits	18	3.8	11.0	41	25.2	0.7
Sides	19	3.7	10.5	36	26.2	0.7
No Beamhouse (sheep)						
Small	14	2.6	15.8	18	20.0	0.2
Medium	6	2.6	15.5	15	20.6	0.2
Large	9	4.4	26.4	55	25.4	0.5
Through-the-Blue						
Small	6	2.6	10.4	57	13.2	0.6
Large	6	2.6	10.1	133	13.2	1.4
Shearling						
Small	5	5.9	12.6	9	33.5	0.3
Large	4	5.3	11.3	24	33.5	0.7
Leather Finishers						
Medium	50	1.5	4.6	24	46.0	0.5
Large	35	5.2	23.3	47	38.8	0.7

Source: Development Planning and Research Associates, Inc.

TABLE F-62

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE LEATHER TANNING AND FINISHING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Chrome Tan/Pulp Hair	209	0.79	1.20	0.24	0.69	6.48	9.12	13.12	6.28
Chrome Tan/Save Hair	8	0.22	0.13	0.06	0.07	0.37	0.87	0.98	12.29
Nonchrome Tan	29	0.61	0.30	0.12	0.14	0.17	1.37	0.96	3.32
Retan (splits/sides)	17	0.06	0.52	0.00	0.11	2.22	2.93	4.29	25.26
No Beamhouse	19	0.28	0.47	0.04	0.14	0.60	1.54	1.54	8.14
Through-the-blue	25	0.25	0.12	0.10	0.08	0.77	1.35	1.80	7.22
Shearlings	11	0.01	0.06	0.00	0.02	0.07	0.18	0.18	1.70
Leather Finishers	25	0.16	0.17	0.00	0.24	0.13	0.73	0.76	3.07
Total	343	2.38	2.97	3.53	1.49	10.81	18.09	23.63	6.89

a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiply 0 by an annuity factor of 0.1814.

Source: Estimates by Arthur D. Little, Inc., based on industry data from Development Planning and Research Associates, Inc.

TABLE F-63

ECONOMIC IMPACT ON THE LEATHER TANNING AND FINISHING INDUSTRY (SIC 3111)

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks[a]	Price Increases	U.S. Demand Reduction	Balance of Payment Effects
Chrome Tan	83	0	0	0	None	None	None
Nonchrome Tan	16	3	200	175,300	None	None	None
Retan (sides/splits)	37	0	0	0	None	None	None
No Beamhouse	29	1	20	36,000	None	None	None
Through-the-blue	12	0	0	0	None	None	None
Shearling	9	0	0	0	None	None	None
Leather Finishers	85	0	0	0	None	None	None
Converters, Brokers, Sales Offices, Dealers, etc.	169	- - - - - - - - - - - Not directly impacted by RCRA requirements - - - - - - - - - -					
Total	430	4	220	211,300	None	None	None

a. Cattlehide equivalents

Source: Development Planning and Research Associates, Inc., estimates based on incremental costs generated by Arthur D. Little, Inc., December 1980, which were slightly different from those shown in Table F-62.

The variability in compliance expenditures within the industry, the strong competitive threat from foreign tanners, and the existing domestic intra-industry competition indicate that the U.S. tanning industry will not be able to raise prices enough to offset ISS compliance expenditures. Furthermore, the impact analysis suggests that some tanners may not choose to continue operation after the imposition of the requirements. While closures and the resulting losses in employment in small communities may affect those areas, such closures are not expected to seriously disrupt the industry as a whole. The lost production could be absorbed by existing tanneries, and their effects on the national balance of payments would be negligible.

The imposition of the ISS will potentially affect 271 leather tanning and finishing facilities. While the model plants affected will have to increase prices from zero to 5.1%, to offset ISS expenditures, no industry-wide price increases are expected. Assuming no price increases, leather plants' returns, cash flows, and net present values will all be reduced. These financial impacts resulted in the projection that four plants may choose to cease operations rather than comply with ISS. These projected closures consist of two small and one medium nonchrome tanneries and one no-beamhouse tannery. The closure of these tanneries is expected to result in the displacement of approximately 220 employees and just over 210,000 cattlehide equivalents. These impacts are expected to have no significant impact on the U.S. demand for leather or the U.S. balance of payments.

16. THE FERROUS METAL SMELTING AND REFINING INDUSTRY (SIC 3312, 3313, 332)

a. Characterization of the Ferrous Metal Smelting and Refining Industry

(1) Industry Description

The ferrous metal smelting and refining industry includes the producers of iron and steel, ferroalloys, and gray, ductile, and malleable iron and steel castings. The industry is large and moderately concentrated. The leading firms typically are large, multiplant, vertically integrated, multinational corporations. Dominant firms have long time horizons, make a number of products, and operate in diverse markets. Employment in the ferrous metal smelting and refining industry totals roughly 750,000 people.

The complexities of the industry make it difficult to generalize about market structure, behavior of individual firms, determination of market price, and corporate and industry financial performance. Consequently, generalizations concerning economic impacts should be viewed with considerable caution.

(2) Segmentation

This study divides the ferrous metal smelting and refining industry into three categories: iron and steel production, ferroalloy production, and foundry production.

(3) Structure

The four-firm concentration ratio for the iron and steel segment in 1978 was 50%, while in the ferroalloy segment it was 70%. The ferrous foundry segment had a much lower four-firm concentration ratio of about 25% in 1978 (Table F-64).

(4) Supply and Demand

The real growth rate projected for 1978-1983 for ferrous metal smelting and refining ranges from a low of 1.0-1.5%/year for ferrous foundries to a high of 1.5-2.5%/year for the iron and steel segment. The ferroalloy segment is expected to grow at a rate of about 2%/year during this period. No major supply constraints are anticipated, assuming that imports of raw materials, e.g., iron, manganese, chrome ores, ferrochrome, or nickel, are not restricted in some manner.

Opportunities for product substitution in these segments are generally low at present, although there are limited opportunities for substitution for some ferrous foundry products.

Import competition is moderate for most iron and steel products and high for most of the important ferroalloys. On the other hand, import competition is low for ferrous foundries.

In the iron and steel segment, imports are limited by the production capacities of foreign producers and their internal (domestic) demand. This results in low to medium import competition, depending on the economic environment worldwide. In the ferroalloy segment, most foreign producers are not constrained by internal domestic demand. Therefore, U.S. producers face severe competition in the important ferroalloys, such as ferrochrome and ferromanganese.

The price elasticity of demand faced by U.S. producers reflects the degree of competition from imports. Thus, elasticity is low to medium for iron and steel, low to high for ferroalloys, and low for ferrous foundries.

(5) Profitability

Profitability in the ferrous metal smelting and refining industry, measured in terms of after-tax return on sales and after-tax return on net income, fluctuated with the economy around a flat trend line between 1972 and 1978 (Table F-65). The median level of profitability in the industry groups for which data are available has ranged from approximately 3% to 6% of sales.

(6) Capital Investment

Capital investment (in current dollars) spurred by competition from abroad has risen steadily in the iron and steel segment. It has exhibited a less even but still upward trend in the ferrous foundry segment (Table F-65).

TABLE F-64

ECONOMIC CHARACTERIZATION OF THE FERROUS METAL SMELTING AND REFINING INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio (%)	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Iron and Steel (SIC 3312)	46,000[a] 33[b]	97,900[c]	87	92[d]	152[d]	~50	1.5-2.5	low to medium	low	low to medium
Ferroalloys (SIC 3313)	1,000[a] 29[b]	1,520[e]	70	12	28[e]	>70	~2	low to high	low	low to high
Ferrous Foundries (SIC 332)	14,000[a] 57[b]	16,500[f]	~80	1,450	1,700	~25	1.0-1.5	low	low to medium	low

[a] US Industrial Outlook and Arthur D. Little, Inc., estimates.

[b] Value added as a percent of production value.

[c] AISI Statistical Reports.

[d] Data supplied by AISI Statistical desk.

[e] US Bureau of Mines — 1978 data. Excludes minor ferroalloys.

[f] Data based on Bureau of Mines and Cast Metal Association figures.

TABLE F-65

FINANCIAL PROFILE OF THE FERROUS METAL SMELTING AND REFINING INDUSTRY
(1972-1978)

Iron and Steel (SIC 3312) and Ferroalloys (SIC 3313)		1978	1977	1976	1975	1974	1973	1972
Profitability[a]								
Net Income After Taxes/Net Sales (%)	upper quartile	7.84	5.25	5.70	6.17	7.20	5.29	4.31
	median	4.32	3.28	4.05	4.45	6.13	4.31	3.21
	lower quartile	1.84	1.43	2.15	2.31	4.27	2.34	1.86
Net Income After Taxes/Net Worth (%)	upper quartile	31.90	16.74	15.08	15.68	21.42	15.48	11.89
	median	17.08	9.33	9.13	10.31	16.81	10.11	6.77
	lower quartile	5.90	3.22	6.22	7.57	13.93	8.96	3.92
Revenues[b]								
Value of Shipments ($ Million)		47,000	50,574.4	46,687.3	42,211.7	49,648.8	38,240.2	28,665
Value Added/Shipments (%)		33	35.7	37.2	37.4	40.4	41.2	42.3
New Capital Expenditures ($ Million)		NA	2,436.4	2,372.6	2,287.8	1,867.3	1,263.9	1,059.1

TABLE F-66 (Continued)

Ferrous Foundries (SIC 332)		1978	1977	1976	1975	1974	1973	1972
Profitability[a]								
Net Income After Taxes/Net Sales (%)	upper quartile	6.96	7.33	6.74	9.25	6.15	5.22	4.86
	median	4.29	4.69	3.53	6.16	4.36	3.56	3.19
	lower quartile	1.77	2.75	1.89	3.52	2.11	2.01	2.07
Net Income After Taxes/Net Worth (%)	upper quartile	23.67	23.54	16.55	24.82	19.31	13.17	15.92
	median	15.98	14.52	11.11	16.11	13.38	8.95	9.39
	lower quartile	8.07	7.58	5.26	10.00	6.15	5.38	5.55
Revenues[b]								
Value of Shipments ($ Million)		14,000	10,883.8	9,787.0	8,871.4	8,535.2	6,857.7	7,042.4
Value Added/Shipments (%)		57	57.5	56.2	56.1	55.3	59.3	61.1
New Capital Expenditures ($ Million)		NA	659.2	643.2	519.6	554.1	297.0	332.6

Sources: [a] Dun and Bradstreet, Ratios of Manufacturing, 1973-1978.

[b] Census of Manufactures, 1972 and 1977 Annual Survey of Manufactures, 1973-1976; 1978 U.S. Industrial Outlook.

b. Economic Impact on the Ferrous Metal Smelting and Refining Industry

(1) Cost of Compliance

Table F-66 shows that the estimated incremental annual cost of compliance with the ISS is expected to be roughly $24 million for the iron and steel segment. This annual cost as a percent of value added will probably be about 0.09% for the average plant. The non-integrated mini-mills and small rerollers with surface impoundments are expected to incur higher-than-average costs as a percent of their value added. Total first-year expenditures for the iron and steel segment will probably exceed $20 million, amounting to an average cost of almost $150,000 per plant.

The incremental annual cost for the ferroalloy segment is expected to be almost $2.5 million, or almost 0.9% of value added. The small and medium-sized ferroalloy plants with surface impoundments are expected to be most affected, with the cost of compliance approaching 2% of value added. The $2.4 million in first-year expenditures is estimated to cost the average plant about $85,000.

Ferrous foundries are estimated to have a total annual cost of almost $10 million, or 1.1% of value added. First-year costs are estimated to be about $11.5 million, or an average of about $6700 per plant.

(2) Economic Impact

Table F-67 shows that price increases are likely (chance of occurrence greater than 75%) for all segments of the ferrous metal smelting and refining industry as plants attempt to cover the cost of the ISS.

On the other hand, the chance of plant closures, job losses, production cutbacks, demand reduction, or balance of payments effects is considered negligible (0.5-10%) for the iron and steel segment.

The adverse impacts of plant closures, job losses, U.S. production cutbacks, and demand reduction are considered possible in the ferrous foundry and ferroalloy segments (chance 26-50%). Although balance of payments effects are also considered possible in the ferroalloy segment, none is expected in the ferrous foundry segment.

17. THE NONFERROUS METAL SMELTING AND REFINING INDUSTRY (SIC 3331, 3332, 3333, 3334, 3339, 3341)

a. Characterization of the Nonferrous Metal Smelting and Refining Industry

(1) Industry Description

The nonferrous metal smelting and refining industry segments are generally large, interrelated, complex, and highly concentrated. The leading firms, although

TABLE F-66

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE FERROUS METAL SMELTING AND REFINING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Iron and Steel (SIC 3312)	15,180.00	6.66	3.29	4.87	2.08	5.53	22.51	24.22	0.09
Ferroalloys (SIC 3313)	290.00	0.72	0.38	0.49	0.24	0.54	2.36	2.48	0.86
Ferrous Foundries (SIC 332)	7,980.00	2.9	3.8	0.66	2.4	1.57	11.49	9.68	1.14

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-67

ECONOMIC IMPACT ON THE FERROUS METAL SMELTING AND REFINING INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Iron and Steel (SIC 3312)	152	negligible	negligible	negligible	likely	negligible	negligible
Ferroalloys (SIC 3313)	28	possible	possible	possible	likely	possible	possible
Ferrous Foundries (SIC 332)	1700	possible	possible	possible	likely	possible	none

Source: Arthur D. Little, Inc., estimates.

of unequal size, are large, multiplant, vertically integrated, multinational corporations. Dominant firms have long time horizons, are typically producers of numerous products, and operate in a diverse range of markets where they often face the threat of substitution from a number of key rival products. The complexities of these industries make it difficult to generalize about market structure, firm behavior, market price determination, and industry financial performance. As a result, generalizations concerning economic impact on individual segments or on the industry as a whole should also be viewed with caution.

(2) Segmentation

For purposes of this study, the nonferrous metal smelting and refining industry has been divided into the following product categories: primary aluminum smelting, primary copper smelting and refining, primary lead smelting and refining, primary zinc refining, secondary aluminum smelting, secondary copper smelting, secondary lead smelting, tungsten (APT), and mercury. These segments of the nonferrous industry together employ about 50,000 people.

Each product category includes those plants primarily engaged in smelting or refining a given metal. Although significant quantities of metal may be produced as by-products or co-products at other plants, or from secondary sources, plants engaged in these activities were not included in the industry sector unless so indicated.

(3) Structure

The primary nonferrous metal segments have four-firm concentration ratios ranging from 70 to 100%. The concentration ratios are lower for the secondary nonferrous metal segments and range from 30% for secondary lead to 50% for secondary copper and aluminum (Table F-68).

(4) Supply and Demand

The real growth rate projected through 1983 for the primary nonferrous metal producers ranges from a low of less than 1%/year for mercury production to a high of 7%/year for the primary and secondary aluminum producers. At the same time, the other nonferrous metal producers are expected to experience a growth of about 2-4%/year. No significant supply constraints (due to capacity limitations) are anticipated in these segments through 1983. In fact, some of them currently have considerable excess capacity.

Product substitution ranges from low in the case of tungsten, mercury, and lead to moderate in the case of zinc, aluminum, and copper.

Import competition is high for mercury, zinc, and primary copper. It is moderate for lead and secondary copper, and low for tungsten and aluminum.

TABLE F-68

ECONOMIC CHARACTERIZATION OF THE NONFERROUS METAL SMELTING AND REFINING INDUSTRY

Industry Segment	Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio (%)	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Primary Aluminum	5,088.4 26[a]	4,356.1	90+	12	31	70	6.9	−0.8	moderate	low
Primary Lead	427.1 13[a]	570	80	4	7	100	1.8	−0.3 to −2	low	moderate
Primary Copper	2,012.8 19[a]	1,343	70	9	16	80	3.6	−0.39 to −1.1	moderate	high
Primary Zinc	277.4 26[a]	406	60	6	6	90	2.0	−0.7 to −2	moderate	high
Secondary Aluminum	1,772.0 18[a]	1,517	90	69	87	50	6.9	−0.2 to −0.08	moderate	low
Secondary Lead	561.3 17[a]	749	70	~50	~80	~30	1.8	−0.2 to −0.4	low	low
Secondary Copper	638.5 19[a]	426	60-70	~40	~60	~50	3.6	−0.39 to −1.1	moderate	moderate
Tungsten (APT)	101.5 10[a]	7.29	70-80	4	4	100	4.9	−0.3 to −0.39	low	low
Mercury	4.19 25[a]	0.95	90	1	1	100	< 1	−0.5	low	high

a. Value added as a percent of production value, estimated.

Sources: USBM Mineral Industry Surveys; ABMS Non-Ferrous Metal Data, 1978; Arthur D. Little, Inc., estimates.

The interaction of product substitution and import competition yields a high elasticity of demand in the case of copper, primary lead and zinc; a moderate elasticity of demand in the cases of mercury, aluminum, and secondary copper; and a low elasticity of demand for secondary lead and tungsten.

(5) Profitability

Profitability in all the segments of the nonferrous metal, smelting, and refining industry fluctuated with the economy around a rather flat trend line between 1972 and 1978. Profitability is measured in terms of after-tax return on sales and after-tax return on net worth. The levels of profitability of the nonferrous metals segments do not differ significantly (Tables F-69 and F-70).

(6) Capital Investment

Capital investment has exhibited an uneven upward trend in nonferrous metals (Table F-68).

b. Economic Impact on the Nonferrous Metal Smelting and Refining Industry

(1) Cost of Compliance

Table F-71 presents the estimated incremental costs to comply with the ISS RCRA regulations for the nonferrous smelting and refining industry model plants. For the total industry, capital expenditures amount to $5.4 million; annual operating, maintenance, and disposal costs are estimated at $4 million; and closure fund costs are $2.45 million per year for 20 years. The closure fund costs are not tax-deductible.

The annualized cost of compliance as a percent of estimated value added averages less than 0.1% for tungsten, mercury, secondary copper, and secondary aluminum. In the primary aluminum segment, the annualized cost as a percent of value added is approximately 0.5%. This percentage averages 2.7% for primary zinc, 0.4% for primary copper, 1.8% for primary lead, and 1.5% for the secondary lead segment.

(2) Economic Impact

The economic impacts of ISS compliance for the nonferrous smelting and refining industry are summarized in Table F-72. The industry-wide analysis of the economic impact has been performed on a micro-economic level for each of the model plants. The results for the model plants have then been combined to obtain industry-wide results. The industry-wide results, in turn, take into account macro interactions of the domestic industry with the rest of the world and with other domestic nonferrous industries.

TABLE F-69

FINANCIAL PROFILE OF THE NONFERROUS METAL SMELTING AND REFINING INDUSTRY

(1972-1978)

Total Industry (SIC 333-334)	1978	1977	1976	1975	1974	1973	1972
Profitability[a]							
Net Income After Taxes/Net Sales (%)	4.3	3.3	3.7	3.1	7.0	5.4	3.7
Net Income After Taxes/Net Worth (%)	10.0	7.0	7.3	5.0	15.1	11.7	6.8
Revenues[b]							
Value of Shipments ($ Million)	–	14,140.2	13,149.3	10,687	13,370.7	9,951.3	8,065.3
Value Added/Shipments (%)	–	30.2	27.5	27.5	30.0	27.1	26.2
New Capital Expenditures[b] ($ Million)	–	710.6	551.2	660.5	632.8	343.7	327.2

Sources: [a]U.S. Federal Trade Commission, Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations, 1972-1977. This data includes nonferrous foundries.

[b]Census of Manufactures, 1972 and Annual Survey of Manufactures, 1973-1977.

TABLE F-70

FINANCIAL PROFILE OF NONFERROUS METALS BY SEGMENT

	Segment: Primary Aluminum	Segment: Primary Lead	Segment: Primary Copper	Segment: Primary Zinc
Profitability[a] – 1977				
Net Income After Taxes/Sales[a] (%)	14	17	8	17
Revenues – 1978				
Value of Shipments ($ Million)	5088.4	427.1	2012.8	277.4
Value Added/Shipments[b] (%)	26	13	19	26

a. Operating profit margins – 1977, company totals.
b. Includes labor, plant overhead, depreciation, and local taxes – 1978.

Source: Standard & Poor's

TABLE F-70 (Continued)

	Segment: Secondary Aluminum	Segment: Secondary Lead	Segment: Secondary Copper	Segment: Tungsten	Segment: Mercury
Revenues – 1978					
Value of Shipments ($ Million)	1772.0	581.3	638.5	101.5	4.19
Value Added/Shipments (%)	18	17	19	10	26

Source: Arthur D. Little, Inc., estimates.

TABLE F-71

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE NONFERROUS METAL SMELTING AND REFINING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Primary Aluminum	1,323	3.09	0.84	1.45	0.65	1.57	7.62	7.27	0.55
Primary Lead	55.5	0.62	0.18	0.14	0.11	0.21	1.18	0.98	1.77
Primary Copper	380	0.70	0.40	0.37	0.18	0.12	1.79	1.41	0.37
Primary Zinc	72.1	0.41	0.18	0.38	0.16	0.50	1.64	1.98	2.76
Secondary Aluminum	319	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Lead	95.4	0.67	0.43	0.11	0.30	0.26	1.78	1.40	1.48
Secondary Copper	121	0.03	0.03	0.00	0.02	0.01	0.11	0.08	0.07
Tungsten	10.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mercury	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2,377.2	5.42	2.06	2.45	1.42	2.58	14.12	13.12	7.00

a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-72

ECONOMIC IMPACT ON THE NONFERROUS METAL SMELTING AND REFINING INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Primary Aluminum	31	unlikely	none	4,500 metric tons	0.13%	0.10%	$6.8 million
Primary Lead	7	none	none	1,800 metric tons	0.15%	0.3%	$1.5 million
Primary Copper	16	none	none	900 metric tons	negligible	< 0.05%	$1.0 million
Primary Zinc	6	possible (2)	possible (1200)	3,600 metric tons	0.4%	0.86%	$4.3 million
Secondary Aluminum	93	none	none	< 900 metric tons	negligible	none	none
Secondary Lead	80	unlikely	none	900 metric tons	0.1%	0.15%	$1 million
Secondary Copper	35	none	none	none	< 0.1%	< 0.05%	none
Tungsten	4	none	none	none	< 0.1%	none	none
Mercury	1	none	none	none	< 0.1%	none	none

Source: Arthur D. Little, Inc. estimates based on incremental costs generated in December 1980, which were slightly different from those shown in Table F-71.

For most of the nonferrous industry subsegments, the economic impact is primarily in the form of balance of payments increases, production cutbacks, and price increases (Table F-72). One segment, the primary aluminum industry, may have serious financial impacts as a result of these regulations. It is estimated that none of the primary aluminum plants will be forced to close, however. The primary copper and primary lead industries will generally experience price increases with subsequent decreases in demand and profitability, but closures are not expected. Mercury, tungsten, secondary copper, and secondary aluminum will, in general, experience a negligible impact as a result of the regulations.

One industry segment, the primary zinc industry, will be more severely affected. The zinc industry has been hard-hit over the past few years with stagnant demand and low prices. Two domestic plants have closed down in the last two years (one has subsequently reopened at reduced capacity). This, coupled with severe international competition from imports, has left the zinc industry in a weakened financial position. The imposition of the ISS compliance costs, especially the non-tax-deductible closure fund costs, will have severe financial effects on the zinc plants. Two of the six plants will have a significant reduction in their after-tax profitability. Depending upon the resource base of the smelter and their perception of future market potential in the zinc industry, they may choose closure rather than incurring the ISS compliance cost, although no closures are projected in the short run.

The economic impact of these regulations on the nonferrous industry is based on conditions as they existed in 1978 and do not include compliance costs for proposed BATEA and PSES effluent guidelines.

18. THE ELECTROPLATING AND METAL FINISHING INDUSTRY (SIC 3471, 3479)

a. Characterization of the Electroplating and Metal Finishing Industry

(1) Industry Description

Electroplating and metal finishing are production operations to improve the surface appearance or quality of an item usually made of a metal or plastic. Electroplating as a finishing operation usually refers to the electro-deposition of such metals as copper, nickel, chromium, zinc, lead, tin, gold, and silver. Metal finishing is both a preparatory and final finishing operation and can include phosphating, chromating, anodizing, and chemical milling and etching. It is quite common for both types of operations to be carried on within the same facility, although electroplating with common metals is the predominant industry operation.

The industry consists of two fundamentally different manufacturing segments. The larger consists of nearly 6,100 "captive" operations, which are in-house or wholly owned subsidiaries, providing metal finishing services to a parent company. Most captives are relatively small operations belonging to large, multiplant, vertically integrated corporations.

The other industry segment consists of the independent producers or job shops that offer metal finishing services on a contract or spot basis. There were 2,940 such plants in 1978. By 1980 the number of plants had declined to 2,400. The decline in the size of the segment is attributed to expected closures associated with compliance with 1979 Pretreatment Standards.

The industry as a whole employs about 180,000 persons and produced metal-finished goods valued at $10.1 billion in 1978 (Table F-73).

(2) Segmentation

This study considers the two industry segments — job shops and captives.

(3) Structure

The four-firm concentration ratio for electroplating and metal finishing job shops is very low (5%) because there are a large number of small producers in this business (Table F-73). A four-firm concentration ratio for captives is not computed because electroplating and metal finishing operations take place in 150 different 4-digit SIC industries.

(4) Supply and Demand

The growth in unit demand for electroplating and metal finishing job shops is expected to be 1% per year (Table F-73). Although there is relatively little product substitution, there are so many producers that the industry is highly competitive. In many large cities, the demand curve facing any individual producer is highly elastic because the customer can easily switch to an alternative supplier. Import competition is low and operating rates of return, though difficult to determine precisely, are probably at reasonable levels because capital requirements for entering the business are low.

(5) Profitability

The average after-tax return on sales for job shops in 1978 is estimated at slightly more than 1%, while the after-tax return on net worth was a little more than 5% (Table F-74). No comparable financial performance data are available for the captive segment because they are defined as cost, not profit, centers.

(6) Capital Investment

New capital expenditures for productive equipment in the job shops were reported in a 1976 Booz-Allen industry survey at an average of $88,000 per year per plant. The range was from $25,000 for the smallest plants (fewer than five production employees) to $200,000 for the largest (employing more than 50 production employees). For the job shops as a whole, capital investment is projected at approximately $200 million annually for 1978. No comparable data on capital investments per capital facilities exist (Table F-74).

TABLE F-73

ECONOMIC CHARACTERIZATION OF THE ELECTROPLATING AND METAL FINISHING INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio (%)	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Job Shops	$ 2,400 65[a]	146	NA	2,940	2,940	5	1.0	moderate	low	low
Captives	106,800 7[a]	1,934	NA	6,077	6,077	–	4	low	low	low
Total	109,200	2,080	NA	9,017	9,017	–	–	–	–	–

a. Value added as a percent of production value.

Source: Dollars 1967 = 100 using implicit price deflators for personal consumption expenditures-services.
Booz-Allen and Hamilton, Inc., 1976-1977 Industry Surveys

TABLE F-74

FINANCIAL PROFILE OF THE ELECTROPLATING AND METAL FINISHING INDUSTRY
(1978)

	Job Shops	Captives
Electroplating and Metal Finishing (SIC 3471,3479)		
Profitability		
Net Income After Taxes/Net Sales (%)	1.3	N/A
Net Income After Taxes/Net Worth (%)	5.3	N/A
Revenues		
Value of Shipments ($ Million)	2,400	106,800
Value Added/Shipments (%)	66	7
New Capital Expenditures ($ Million)	200	N/A

Source: Arthur D. Little, Inc., estimates based on Economic Analysis of Proposed Pretreatment Standards for Existing Sources of the Electroplating Point Source Category prepared by Booz-Allen and Hamilton Inc., for the U.S. EPA, Office of Planning and Evaluation, Economic Analysis Division, 1979.

b. Economic Impact on the Electroplating and Metal Finishing Industry

(1) Cost of Compliance

The cost of compliance with the ISS regulations appears in Table F-75. The total first-year expenditure is expected to be about $35 million (almost $12,000 per plant) for job shops and about $125 million (about $20,000 per plant) for captives.

The total annual cost is estimated at about $23 million for job shops and $140 million for captives, or approximately $163 million for the industry as a whole.

The cost of compliance as a percent of value added for the job shops segment of the electroplating industry is 2.9% and for the captives segment, 33.6% (Table F-75).

These cost increases represent the average impacts across the industry segments. Some plants in these segments are expected to bear larger impacts and others smaller impacts than the average. For both job shops and captives, it appears that small, previously unregulated, plants (below 10,000 gallons per day), will experience the largest cost burden.

(2) Economic Impact

Under the ISS regulations 48 job shops out of 2,940 are expected to close (Table F-76). This could result in 1,340 job losses and $49 million in production cutbacks. Price increases of 6.6% are expected on a full cost pass-through basis by all the remaining job shops. No demand reduction or balance of payments effects are likely.

The captive operations are not expected to be adversely affected by the ISS. No complete plant closures are forecast, nor are any in-house captive operations forecast to shut down in favor of purchasing finishing services from independent vendors. The expected price increase passed through on finished goods is estimated at less than 1%.

19. THE SPECIAL MACHINERY MANUFACTURING INDUSTRY (SIC 355, 357)

a. Characterization of the Special Machinery Manufacturing Industry

(1) Industry Description

The special machinery manufacturing industry includes special industry machinery, i.e., textile machinery, food products machinery, paper manufacturing equipment, and printing machinery (SIC 355); and office, computing, and accounting machines (SIC 357). Special industry machinery plants are concentrated in the major manufacturing areas of the country and employ approximately 190,000 people. The office, computing, and accounting machine segment is changing rapidly because of innovations in underlying technology, products, and market. This segment employs about 500,000 people in the United States.

TABLE F-75

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE ELECTROPLATING AND METAL FINISHING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Job Shops	1,560	6.60	17.69	1.34	4.95	4.20	34.80	23.06	2.91
Captives	7,476	35.57	46.61	9.19	18.95	15.67	125.98	139.89	33.58

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Estimates by Arthur D. Little, Inc., based on industry data provided by Arthur D. Little, Inc., and Booz-Allen and Hamilton, Inc.

TABLE F-76

ECONOMIC IMPACT ON THE ELECTROPLATING AND METAL FINISHING INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Job Shops	2,940	48	1,340	$49.0 Million	6.6%[a]	None	None
Captives	6,077	None	None	None	< 1.0%[a]	None	None

a. Will be passed through to final product.

Source: Booz-Allen and Hamilton, Inc., based on incremental costs generated by Arthur D. Little, Inc., and Booz-Allen and Hamilton, Inc., which were half of those shown in Table F-75.

(2) Segmentation

This report analyzes the two segments of the special machinery manufacturing industry separately (Table F-77).

(3) Structure

The office, computing, and accounting machine segment has a moderately high concentration ratio. The segment has 1400 plants, but only about 400 of them are affected by the regulations. The other 1000 plants do not generate hazardous waste. The special industry machinery segment, on the other hand, has a low concentration ratio and, out of 4200 plants, 2700 are affected.

(4) Supply and Demand

The price elasticity of demand for office, computing, and accounting machines is moderate, because of a moderate degree of product substitution coupled with import competition. Demand through 1983 is expected to grow 10-25% annually, depending on the product, for the office, computing, and office machine segment, and 2.5-3.5% for the special industry machinery segment. No supply constraints are anticipated in the near term.

(5) Profitability

From 1972 to 1976, profitability for these two segments of special machinery manufacturing has fluctuated with the state of the economy, but the general trend has been upward. In 1977, the median after-tax profit on sales was about 6.8% for the office, computing, and accounting segment and 3.8% for the special industry machinery segment (Table F-78).

(6) Capital Investment

Capital expenditures for the office, computing, and accounting machine segment increased dramatically, by nearly 200%, between 1972 and 1977. Over the same period, capital expenditures in the special industry machinery segment increased 60%.

b. Economic Impact on the Special Machinery Manufacturing Industry

(1) Cost of Compliance

Table F-79 shows that the estimated incremental annual cost of compliance with the ISS is about $29 million for the special industry machinery segment and $4 million for the office, computing, and accounting machine segment. This cost is about 0.7% of value added for the special industry machinery segment and 0.1% for the office, computing, and accounting machine segment.

TABLE F-77

ECONOMIC CHARACTERIZATION OF THE SPECIAL MACHINERY MANUFACTURING INDUSTRY

Industry Segment	1978 Production Value ($ Million)	Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Special Industry Machinery (SIC 355)	9,800 57.0[a]	N/A	80	3,250	4,200	30	2.5-3.5	none to low[b]	none to low[b]	negligible to high
Segment Impacted	6,200 57[a]				2,700					
Office Computing and Accounting Machines (SIC 357)	20,800 69.5[a]	N/A	80	700	1,400	60	10-25	moderate	moderate	moderate to high[b]
Segment Impacted	6,500 60[a]				400					

a. Value added as a percent of production value.

b. Depending on product.

Source: Arthur D. Little, Inc., estimates based on U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977 Preliminary Report.

•TABLE F-78

FINANCIAL PROFILE OF THE SPECIAL MACHINERY MANUFACTURING INDUSTRY
(1972-1978)

	1978		1977	1976	1975	1974	1973	1972
Special Industry Machinery (SIC 355)								
Profitability[a]								
Net Income After Taxes/Net Sales (%)		upper quartile	5.3	6.6	6.8	6.1	5.4	5.3
	3.8	median	3.8	4.6	3.8	3.5	3.7	3.0
		lower quartile	2.0	2.3	1.7	1.8	1.8	1.0
Net Income After Taxes/Net Worth (%)		upper quartile	16.2	18.9	15.7	18.6	13.7	13.9
	9.6	median	9.6	11.4	11.2	10.0	9.9	7.0
		lower quartile	3.9	5.6	5.1	4.0	4.4	1.7
Net Income After Taxes/Value Added (%)	6.7							
Revenues[b]								
Value of Shipments ($ Million)	6,200		9,520.2	9,453.5	8,891.3	8,561.7	7,297.6	6,207.2
Value Added/Shipments (%)	57.0		57.2	54.7	54.8	59.2	59.9	79.0
New Capital Expenditures ($ Million)			255.6	214.9	199.5	283.7	202.9	160.0
Office Computing and Accounting Machines (SIC 357)								
Profitability[a]								
Net Income After Taxes/Net Sales (%)		upper quartile	10.2	8.2	7.3	6.7	7.4	NA for 1972
	6.8	median	6.8	4.4	3.7	3.7	4.3	
		lower quartile	3.9	0.8	0.6	1.4	1.6	
Net Income After Taxes/Net Worth (%)		upper quartile	29.9	17.1	15.5	17.6	16.0	
	18.7	median	18.7	11.6	9.5	11.9	10.7	
		lower quartile	11.6	3.0	2.5	3.9	2.6	
Net Income After Taxes/Value Added (%)	11.3							
Revenues[b]								
Value of Shipments ($ Million)	6,500		17,531.1	13,722.8	11,528.0	12,178.8	10,063.9	8,604.9
Value Added/Shipments (%)	60.0		59.6	59.0	55.9	58.6	59.0	57.0
New Capital Expenditures ($ Million)			855.9	480.3	389.5	377.9	281.7	287.0

Sources: [a]Dun and Bradstreet, Ratios of Manufacturing 1977. No published data for 1978.
[b]U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1972 and 1977 and Annual Survey of Manufactures 1973-1978.

TABLE F-79

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE SPECIAL MACHINERY MANUFACTURING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1976 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Special Industry Machinery (SIC 355)	3,535.00	1.82	28.52	0.21	2.33	7.80	40.70	20.83	0.67
Office, Computing, and Accounting Machinery (SIC 357)	3,900.00	0.68	4.41	0.10	0.54	1.36	7.11	4.48	0.12

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

Total costs for the first year are estimated at an average of about $15,000 per plant for the special industry machinery segment. In this segment, costs as a percent of value added vary from more than 3% for small plants with surface impoundments to less than 0.1% for large plants without surface impoundments. Plants at the high end of the range could incur annual costs exceeding $40,000 per plant.

In the office, computing, and accounting machine segment, total first-year costs are estimated at more than $7 million, or about $18,000 per plant. The cost as a percent of value added varies from more than 1% for small plants to 0.02% for large plants.

(2) Economic Impact

Plant closures and job losses are considered unlikely (chance of occurrence 11-25%) in both segments of the special machinery industry (Table F-80). However, this conclusion assumes that no modifications in the manufacturing processes for printed circuit boards or semiconductor chips are required. Should such modifications be necessary, the chance of plant closures and job losses would be much higher in the office, computing, and accounting machine segment. The small, specialized job shops in the poorer sections of large cities are considered most vulnerable.

Firms in both segments are likely to pass the cost of RCRA on to their customers. The higher prices are not expected to affect demand but may marginally encourage imports of electronic components. This, in turn, means there is a negligible chance (0.5-10%) that U.S. production cutbacks could occur in office, computing, and accounting machines.

20. THE ELECTRONIC COMPONENT INDUSTRY (SIC 367)

a. Characterization of the Electronic Component Industry

(1) Industry Description

The electronic component industry manufactures integrated circuits, semiconductors, electron tubes, inductors, capacitors, and resistors used as components of such final products as radios, computers, and navigation systems. The frequency of technological innovation, the variety of product markets, the volatility of demand, and the interrelationships among component markets complicate the structure of this industry.

(2) Segmentation

This study has analyzed the electronic component industry as a single entity.

(3) Structure

The electronic component industry has approximately 4500 plants. The four-firm concentration ratio varies considerably among products, but the average is about 45% (Table F-81).

TABLE F-80

ECONOMIC IMPACT ON THE SPECIAL MACHINERY MANUFACTURING INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Special Industry Machinery (SIC 356)	2700	unlikely	unlikely	none	likely	none	none
Office, Computing and Accounting Machines (SIC 357)	400	unlikely[a]	unlikely	negligible	likely	none	negligible

[a] This estimate assures that no substantial capital costs will be required to modify the equipment used to manufacture printed circuit boards and semiconductor chips.

Source: Arthur D. Little, Inc., estimates.

TABLE F-81

ECONOMIC CHARACTERIZATION OF THE ELECTRONIC COMPONENT INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plant	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Electronic Components (SIC 367)	18,682 (60.4%)[a]	N/A	80-100[b]	2,500	4,500	45	7-15[b]	low[b] to moderate	low[b] to moderate	low to high[b]

a. Value added as a percent of production value.

b. Depending on product.

Source: Arthur D. Little, Inc., estimates based on U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977 Preliminary Report.

(4) Supply and Demand

Unit demand in the electronic component industry is expected to grow 7-15%/year through 1983. The price elasticity varies from low to moderate and import competition varies from low to high. Product substitution varies according to the product being evaluated from low to moderate. Some capacity constraints are anticipated over the forecast period, especially in integrated circuits.

(5) Profitability

The profitability of the electronic component industry reflects the general state of the economy as well as the industry's shifting product mix and volatile demand. Profits vary widely. The median firm in the industry earned almost 6% on sales and just over 15% on net worth in 1978. Net income after taxes as a percentage of value added was estimated at 9.4% in 1978 (Table F-82).

TABLE F-82

FINANCIAL PROFILE OF THE ELECTRONIC COMPONENT INDUSTRY

(1978)

Profitability[a]	
Net Income After Taxes/Net Sales (%)	5.7
Net Income After Taxes/Net Worth (%)	15.2
Net Income After Tax/Value Added (%)	9.4
Revenues[b]	
Value of Shipments ($ Million)	18,682.1
Value Added/Shipments (%)	60.4

Sources: a. Dun and Bradstreet, Ratios of Manufacturing, 1978
b. U.S. Department of Commerce, U.S. Industrial Outlook, 1980.

(6) Capital Investment

New capital expenditures in the electronic component industry grew rapidly between 1972 and 1974, dropped substantially in 1975, then rose to $772.7 million in 1977 (Table F-83). According to the U.S. Department of Commerce, 1978 capital expenditures were $915.0 million.

b. Economic Impact on the Electronic Component Industry

(1) Cost of Compliance

Table F-84 shows that the estimated incremental annual cost of compliance with the ISS is about $48 million. This annual cost as a percent of value added is

TABLE F-83

FINANCIAL PROFILE OF THE ELECTRONIC COMPONENT INDUSTRY

(1972-1977)

Total Industry (SIC 367)		1977	1976	1975	1974	1973	1972
Profitability[a]							
Net Income After Taxes/Net Sales (%)	upper quartile	8.2	8.1	6.0	9.6	7.0	5.3
	median	4.8	4.8	3.6	4.0	4.1	3.4
	lower quartile	2.8	2.8	0.6	2.2	1.8	1.0
Net Income After Taxes/Net Worth (%)	upper quartile	23.2	21.6	16.7	19.6	20.5	15.4
	median	14.0	12.4	9.9	14.3	14.3	8.9
	lower quartile	6.3	5.4	1.3	6.9	7.0	3.7
Revenues[b]							
Value of Shipments ($ Million)		15,137.0	12,432.7	10,089.0	11,300.9	10,782.9	8,836.6
Value Added/Shipments (%)		60.2	60.9	59.3	61.6	61.2	60.1
New Capital Expenditures ($ Million)		772.7	650.5	536.2	785.3	628.8	343.8

Sources:

a. Dun and Bradstreet, Ratios of Manufacturing, 1973-1977.

b. U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures, 1973-1976, and Census of Manufactures, 1977.

TABLE F-84

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE ELECTRONIC COMPONENT INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Electronic Components (SIC 367)	11,284.00	4.93	54.53	1.97	3.73	15.33	80.50	48.04	0.43

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

almost 0.4%. This percentage varies from 0.02% for large plants without surface impoundments to more than 4% for small plants with surface impoundments.

First-year expenditures are estimated to be about $80 million, or an average of about $18,000 per plant.

(2) Economic Impact

Table F-85 shows that plant closures and job losses in the electronic component industry are possible (chance of occurrence 26-50%). This conclusion assumes no modifications in the manufacturing processes are required for printed circuit boards or semiconductor chips. Price increases are probable (chance 51-75%), but some firms may not be able to pass on the cost of RCRA because of the threat of imports. Balance of payments effects are considered unlikely (chance 11-25%) as are U.S. production cutbacks. The chance of U.S. demand reduction is negligible (0.5-10%).

21. THE BATTERY INDUSTRY (SIC 3691, 3692)

a. Characterization of the Battery Industry

(1) Industry Description

The battery industry consists of approximately 125 firms that operate 260 manufacturing plants. Although there are many small independent battery firms, 10 major companies dominate the industry. Almost 90% of the value of shipments comes from plants employing 100 or more people. Hazardous wastes are generated in the battery manufacturing process.

(2) Segmentation

The battery industry is segmented according to the major battery types: (1) storage (secondary) batteries, and (2) primary batteries. The two main types of storage batteries are lead-acid (typified by the SLI — starting, lighting, and ignition — automotive battery) and nickel-cadmium. The two principal primary battery types are carbon-zinc and alkaline-manganese, used primarily in flashlights and radios, but miniature (button) cells are rapidly growing in importance.

(3) Structure

There are approximately 207 storage battery plants, about 195 of which manufacture lead-acid batteries (Table F-86). The four-firm concentration ratio is 60% for storage batteries and 90% for primary batteries. Of the 10 leading battery manufacturers, two manufacture both storage and primary batteries, two manufacture only primary batteries, and the other six manufacture only storage batteries. Many plants manufacture multiple battery types, particularly in the primary battery industry. Product substitution and import competition are low for the storage battery segment and low to moderate for the primary battery segment. As a result, the price elasticity of demand tends to be lower for storage batteries than for primary batteries.

TABLE F-85

ECONOMIC IMPACT ON THE ELECTRONIC COMPONENTS INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures[a]	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Electronic Components (SIC 367)	4500	possible	possible	unlikely	probable	negligible	unlikely

[a] A few plants in the industry that handle specialized products utilizing hazardous materials or processes may close as a result of adverse cost impact.

Source: Arthur D. Little, Inc., estimates.

TABLE F-86

ECONOMIC CHARACTERIZATION OF THE BATTERY INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
Storage Batteries (SIC 3691)	2,150 47[a]	75.0	N/A	110	207	60	3.0	low	low	low
Primary Batteries (SIC 3692)	725 51[a]	1,778.0	N/A	15	56	90	7.0	low to moderate	low to moderate	low to moderate

a. Value added as a percent of production value.

Source: Arthur D. Little, Inc., estimates based on U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1977 Preliminary Report.

(4) Supply and Demand

The volume of storage batteries sold is expected to increase 3%/year from 1978 to 1983, while the volume of primary batteries sold is likely to increase 7%/year over the same 5 years. Because of significant changes in production technology for storage batteries and a changing product mix in the primary battery segment, no meaningful estimates can be made of capacity utilization in either segment.

(5) Profitability

The 10 major battery manufacturing firms had an average after-tax profit estimated at 4.6% of sales from 1975 through 1977 (Table F-87). Margin as a percent of sales in the storage battery segment may have been somewhat lower in 1978 as a result of the extraordinary rise in the price of lead, not all of which the battery manufacturers could recover (Table F-88). The smaller companies in the storage battery segment find it difficult to maintain profits when faced with both the capital cost of the new equipment required to remain competitive and the cost of meeting government regulations. In recent years, many of these small firms have abandoned the less-profitable manufacturing operations in order to distribute batteries purchased from the major firms. After-tax net income as a percent of value added is estimated at 9.2% for storage batteries and 9.1% for primary batteries.

(6) Capital Investment

Capital expenditures increased steadily for both segments in the 1972-1977 period through expansion, innovation, and replacement of worn out equipment (Table F-87). Capital expenditures per sales dollar are greater for storage batteries than for primary batteries because the storage battery segment is more capital-intensive.

b. Economic Impact on the Battery Industry

(1) Cost of Compliance

Table F-89 shows that the estimated incremental annual cost of compliance with the ISS is about $10 million for the storage battery segment and $0.4 million for the primary battery segment. This annual cost as a percent of value added amounts to about 1% for storage batteries and 0.1% for primary batteries.

Total first-year costs for the storage battery segment are estimated to be about $9 million, or an average of $43,000 per plant. The degree of impact of RCRA varies significantly from about 2.5% of value added for small plants to less than 1% for large plants.

The primary battery segment is expected to incur substantially lower costs. First-year expenditures are likely to total about $540,000 or an average of about $10,000 per plant.

TABLE F-87

FINANCIAL PROFILE OF THE BATTERY INDUSTRY

(1972-1978)

Storage Batteries (SIC 3691)	1977	1976	1975	1974	1973	1972
Profitability						
Net Income After Taxes/Net Sales (%)	←		4.6%[a]		relatively unchanged	
Revenues						
Value of Shipments ($ Million)	1,975.4	1,519.0	1,302.3	1,234.2	1,070.8	971.3
Value Added/Shipments (%)	46.8	47.6	44.4	49.9	50.0	49.3
New Capital Expenditures ($ Million)	121.5	86.2	77.1	60.2	39.4	30.8
Primary Batteries (SIC 3692)						
Profitability						
Net Income After Taxes/Net Sales (%)	←		4.6%[a]		relatively unchanged	
Revenues						
Value of Shipments ($ Million)	651.1	627.1	437.7	423.3	380.7	348.1
Value Added/Shipments (%)	50.8	57.5	59.7	57.5	61.0	63.6
New Capital Expenditures ($ Million)	32.9	24.8	15.4	13.2	7.9	7.2

a. Industry average for 10 major battery manufacturers from A.T. Kearney, Inc. "Economic Impact Analysis of Hazardous Waste Management Regulations on the Batteries, Electronics, and Special Machinery Industries." Draft report to U.S. EPA Office of Solid Waste, November 1977.

Sources: U.S. Department of Commerce, Bureau of the Census, Census of Manufactures, 1972 and 1977, and Annual Survey of Manufactures, 1973-1976.

TABLE F-88

FINANCIAL PROFILE OF THE BATTERY INDUSTRY BY SEGMENT

(1978)

	Storage Batteries (SIC 3691)	Primary Batteries (SIC 3692)
Profitability[a]		
Net Income After Taxes/Net Sales (%)	4.3	4.6
Net Income After Taxes/Net Worth (%)	N/A	N/A
Net Income After Tax/Value Added (%)	9.2	9.1
Revenues[b]		
Value of Shipments ($ Million)	2,150	726
Value Added/Shipments (%)	46.8	50.8

Sources: a. Arthur D. Little, Inc., estimates.
b. U.S. Department of Commerce, U.S. Industrial Outlook, 1980.

TABLE F-89

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE BATTERY INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Storage Batteries (SIC 3691)	1,006.20	2.04	1.86	0.82	1.20	3.33	9.28	10.27	1.02
Primary Batteries (SIC 3692)	368.30	0.17	0.16	0.06	0.09	0.04	0.54	0.42	0.11

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

(2) Economic Impact

Because of the combination of relatively slow growth and relatively high annual costs, plant closures are possible (chance of occurrence 26-50%) in the storage battery segment (Table F-90). Since these plants are generally not part of complexes where laid-off workers can be readily absorbed, job losses in this segment are also considered possible. Price increases are likely (chance greater than 75%), but no demand reduction is expected. Lost production can be made up by the remaining producers in the industry. No balance of payments effects are expected.

High demand growth and relatively low compliance cost increases mean that RCRA will be a lesser burden to the primary battery segment. The small costs of the regulations can be easily passed on to the customers. No other impacts are expected.

22. THE DRUM RECONDITIONING INDUSTRY (SIC 5085)

a. Characterization of the Drum Reconditioning Industry

(1) Industry Description

As a small service industry, the drum reconditioning industry specializes in cleaning steel drums for reuse. There are approximately 190 firms with a total of 200 plants in this industry. Reconditioning plants are typically located in major metropolitan areas in states with a high concentration of small to medium-sized chemical companies. Competition is usually on a local or regional basis. Total 1978 production equaled nearly 50 million drums with a total production value of about $500 million. The industry has approximately 6000 employees.

The petroleum industry is the largest user of reconditioned drums and the chemical industry ranks second. The paint and varnish industries are also major users.

Drum reconditioners employ two basic reconditioning (cleaning) technologies: 1) incineration, i.e., burning out the inside of the drum (principally for drums with removable tops), and 2) washing in a caustic soda bath (principally for drums with fixed tops). Most firms handle both types of drums and use both cleaning methods. The industry generates waste in three areas in a plant. As drums are received, chemical residues are poured off to ready them for cleaning. Wastes are also generated as a solid dry residue after incineration (from the contents and the exterior paint); or as a solid moist sediment from the caustic soda wash tank. Wastes are typically disposed of off site and are sometimes commingled, depending on the quantity handled.

(2) Segmentation

There are no discernible segments in this industry; therefore, this study treats it as a single business activity.

TABLE F-90

ECONOMIC IMPACT ON THE BATTERY INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Storage Batteries (SIC 3691)	207	possible	possible	none	likely	none	none
Primary Batteries (SIC 3692)	56	none	none	none	likely	none	none

Source: Arthur D. Little, Inc., estimates.

(3) Structure

There are a large number of small firms in this business; few firms have more than one plant location. The four-firm concentration ratio is low, with the four largest firms estimated to account for about 10-15% of total production (Table F-91).

(4) Supply and Demand

Through 1983, the volume of reconditioned drums is expected to grow about 4-6%/year. Demand elasticity is a complex function of selling prices and the price differential between reconditioned drums and alternative types of containers. At low prices and high price differentials, e.g., with new steel drums, the demand elasticity is low; at high prices and low price differentials, the demand elasticity is moderately high. Competition from imports is virtually nonexistent and product substitution is limited because paper or plastic containers generally cannot perform a comparable function. Principal substitute products are new steel drums, plastic-lined fiberboard drums, reusable plastic drums, and, in a very limited number of cases, multi-wall paper/plastic reinforced bags. The supply of reconditioned drums may be limited by an adequate supply of drums for reconditioning. Thin-gauge steel drums and plastic drums often do not survive the reconditioning process and cannot be used again. Lined fiberboard drums will limit the supply of used drums for reconditioning. Capacity utilization is high but is not expected to limit the supply of reconditioned drums.

(5) Profitability

The after-tax profitability of this industry was reasonably high in 1978 with respect to both return on sales and return on net worth (Table F-92), although financial data for the industry or individual firms are not available. Members of the National Barrel and Drum Association suggested that 1978 was stronger than 1977 and the 1978 after-tax return on sales was in the neighborhood of 5%, with an after-tax return on net worth in the 15-20% range. Most of the firms in this industry are small, family-run activities with a strong commitment to staying in the business. Therefore, the number of firms is fairly constant and somewhat independent of profitability. Actual profitability of individual firms and the spread about the industry "norm" can be expected to be very large.

(6) Capital Investment

No data on capital investment are available; it is believed, however, that annual capital investments are small and related to mobile equipment (trucks) and production equipment (more efficient burners and better wash tanks).

b. Economic Impact on the Drum Reconditioning Industry

(1) Cost of Compliance

Table F-93 shows that the incremental cost of compliance with the ISS in the first year is estimated at roughly $2.5 million. Since almost all drum reconditioners

TABLE F-91

ECONOMIC CHARACTERIZATION OF THE DRUM RECONDITIONING INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Million Units)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio (%)	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competitio
Drum Reconditioning (SIC 5085)	500 (60%)[a]	50	85+	190	200	10-15	4-6	low to moderately high	low	none

a. Value added as a percent of production value.

Sources: National Barrel & Drum Association, Washington, D.C.; Energy Resources Co., Inc., Economic Impact Analysis of Hazardous Waste Management Regulations on Selected Generating Industries, Draft Report submitted to U.S. EPA, Office of Solid Waste Management, December 1978.

TABLE F-92

FINANCIAL PROFILE OF THE DRUM RECONDITIONING INDUSTRY

(1977 and 1978)

	Industry Averages	
Total Industry (SIC 5085)	**1978**	**1977**
Profitability		
Net Income After Taxes/Net Sales (%)	5	3
Net Income After Taxes/Net Worth (%)	15-20	12-15
Revenues		
Value of Shipments ($ Million)	$500	$415
Value Added/Shipments (%)	60	55

Sources: Arthur D. Little, Inc., estimates based on interviews with members of the National Barrel and Drum Association; Energy Resources Co., Inc., "Economic Impact Analysis of Hazardous Waste Management Regulations on Selected Generating Industries." Draft Report to U.S. EPA, Office of Solid Waste Management, December 1978.

are expected to dispose of their waste off site, the off-site disposal costs are estimated at a significant $880,000 annually.

The average annual cost of RCRA as a percent of value added is expected to be about 0.9%. The percentage impact is expected to be about 2% for the small firms and less than 1% for the large and medium-sized firms in the industry.

(2) Economic Impact

Demand for reconditioned drums is expected to grow 4-6%/year over the next three years. With product substitution low and operating rates at over 85%, the industry is expected to pass on the cost of the ISS to its customers in the form of price increases. No other adverse impacts are expected (Table F-94).

23. THE CHEMICAL WHOLESALING INDUSTRY (SIC 5161)

a. Characterization of the Chemical Wholesaling Industry

*(1) Industry Description**

The chemical wholesaling industry buys and sells chemicals and also provides transportation, storage, market information, financing, product standardization,

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*Material in this section was developed by Energy Resources Co., Inc., in "Economic Impact Analysis of Hazardous Waste Management Regulations on Selected Industries," Draft Report to U.S. EPA, Office of Solid Waste Management, December 1978. Additional confirming work was done by Arthur D. Little, Inc.

TABLE F-93

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE DRUM RECONDITIONING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Drum Reconditioning (SIC 5085)	300.00	0.39	0.72	0.02	0.56	0.88	2.58	2.81	0.94

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

TABLE F-94

ECONOMIC IMPACT ON THE DRUM RECONDITIONING INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Drum Reconditioning (SIC 5085)	200	none	none	none	likely	none	none

Source: Arthur D. Little, Inc., estimates.

and some disposal and preprocessing services to its customers. Wholesalers usually serve customers who cannot or prefer not to buy in quantity directly from producers. The chemical and allied products wholesaling industry distributes such chemicals as acids, industrial chemicals, dyestuffs, industrial salts, plastic materials, resins, and turpentine. Not included in this industry are those companies that distribute primarily ammunition (SIC 5041), agricultural chemicals and pesticides (SIC 5122), and paints and varnishes (SIC 5198), although chemical wholesalers may carry small amounts of products from these other SIC codes.

The chemical wholesaling industry is characterized by a large number of firms, a lack of substantial barriers to entry, and generally low profit margins. In 1978, approximately 5100 firms had 7400 establishments (Table F-95). Of these, an estimated 66% belonged to merchant wholesalers, 25% to manufacturers' sales branches and sales offices, and the remaining 9% to merchandise agents and brokers.

Sales and employment in the industry have grown at a moderate rate in recent years. In 1978, sales totaled about $44.4 billion. About 78%, or $34.7 billion worth of the sales volume, is attributable to the manufacturers' sales branches and sales offices. The merchant wholesalers' sales of $8.3 billion accounted for 19% of total sales, and the merchandise agents and brokers' sales of $1.5 billion were 3% of the total. The industry employed an estimated 92,800 people in 1978. An examination of the number of establishments by employment-size class reveals that most establishments have fewer than 20 employees. According to 1977 data from the U.S. Census Bureau's *County Business Patterns*, 49% employed one to four people, 37% employed 5 to 19, 10% employed 20 to 49, and only 4% employed more than 49 people.

(2) Segmentation

The chemical wholesaling industry can be segmented into three types of chemical distributing firms: merchant wholesalers, manufacturers' sales branches and sales offices, and merchandise agents and brokers. Of these, only merchant wholesalers and manufacturers' sales branches have warehouse space and typically offer chemical repackaging services. Since hazardous wastes are generated on a routine basis only by firms performing repackaging operations for liquids and since only 70% (estimated) of merchant wholesalers perform these operations, the industry segment of prime interest with respect to waste generation is the 70% of the merchant wholesalers segment that repackages liquids.

(3) Structure

The Bureau of the Census does not develop concentration ratios for the chemical wholesaling industry. Concentration ratios appear to be low, however, except for small markets in certain areas where the ratios could be substantial. Concentration ratios could be misleading measures of market power to the extent that customers can order directly from the manufacturer.

TABLE F-96

ECONOMIC CHARACTERIZATION OF THE CHEMICAL WHOLESALING INDUSTRY

Industry Segment	1978 Production Value ($ Million)	1978 Production (Thousand Metric Tons)	Capacity Utilization (%)	Number of Producers	Number of Plants	Four-Firm Concentration Ratio (%)	Unit Demand Growth (%/Year 1978-83)	Price Elasticity of Demand	Product Substitution	Import Competition
(SIC 5161) Merchant Wholesalers	8,280 (19%)[a]	4,600	NA	NA	4,900	NA	2.8	moderate	high	low to moderate
Merchant Wholesalers Affected by Regulation	5,700 (19%)	–	–	–	3,400	–	–	–	–	–
Manufactures' Sales Branches and Sales Offices	34,650 (NA)[b]	1,850	NA	NA	1,900	NA	3.0	moderate	high	low to moderate
Merchandise Agents and Brokers	1,510 (NA)[b]	600	NA	NA	700	NA	2.8	moderate	high	low to moderate
Total	44,430 (NA)[b]	7,000	NA	5,100	7,400	low to moderate	2.9	moderate	high	low to moderate

a. Value added as a percent of production value.

b. NA = not available or not applicable.
Numbers may not add due to rounding.

Sources: Census of Wholesale Trade, 1972; U.S. Department of Commerce, Bureau of the Census, *County Business Patterns*, 1977; and Arthur D. Little, Inc., estimates.

(4) Supply and Demand

The demand for wholesaling services has been increasing in recent years. A major factor behind this increase is that many customers have been choosing to reduce chemical inventories as a cost-cutting measure, thereby increasing their reliance on local distributors. Growth in warehousing services, reflected by sales volume, is expected to increase at a rate of 2.9%/year from 1978 through 1983.

Product substitution, or more appropriately service substitution, is high in the chemical wholesaling industry. Industrial purchasers of chemicals have a variety of paths available to them for securing necessary supplies. Depending on the type and quantity of chemical needed, the industrial consumer may order directly from the manufacturer, through the manufacturers' sales offices or branches, or through an independent chemical distributor. In major industrial areas, a significant number of firms can be possible points of contact. For exotic chemicals, fewer firms may serve the area but there appears to be some choice in most cases.

(5) Profitability

After-tax profitability in the chemical wholesaling industry is low. Table F-96 shows that in terms of net income after taxes as a percentage of sales, profitability ranged from 1.2% to 1.6% between 1972 and 1974, and from 1.9% to 2.5% between 1975 and 1978. Profitability in 1978 was 2.3%. In estimating anticipated profits, chemical wholesalers tend to project 3% as a high. In terms of net income after taxes as a percentage of net worth, profitability has ranged from 7.5% to 16.0% in the 1972-1978 period. Profitability in 1978 was 10.6%.

Low profit levels can be linked with the high level of price competition found in the industry. The highest product price markups appear to exist on the periphery of the industry, i.e., for sales of specialized chemicals to small-volume users. Purchasers in outlying areas also may pay higher prices for chemicals because of the distance from distributors in urban areas. Such customers will tend to have the least recourse to switching suppliers or to maintaining large chemical inventories.Product price markups in the industry vary 5-20%, and may go still higher in isolated cases.

(6) Capital Investment

Capital investment in the chemical wholesaling industry can be expected to follow the long-term trend in the chemical industry. From 1972 to 1978, the level of capital spending in the chemical processing industries increased at a rate of 4-6%/year in constant dollar terms.

b. Economic Impact on the Chemical Wholesaling Industry

(1) Cost of Compliance

Table F-97 shows that the estimated incremental annual cost of compliance with the ISS is almost $6 million. This amounts to an average cost of about $1700

TABLE F-96

FINANCIAL PROFILE OF THE CHEMICAL WHOLESALING INDUSTRY

(1972-1978)

Total Industry (SIC 5161)	1978	1977	1976	1975	1974	1973	1972
Profitability[a]							
Net Income After Taxes/Net Sales (%)	2.3	1.9	2.2	2.5	1.6	1.3	1.2
Net Income After Taxes/Net Worth (%)	10.6	10.8	13.3	16.0	9.6	7.5	7.6
Revenues							
Value of Shipments[b] ($ Million)	44,400[e]	40,300[e]	36,500[e]	33,100[e]	30,000[e]	27,200[e]	24,600
Value Added/Shipments (%)	15-20%	NA	NA	NA	NA	NA	NA
New Capital Expenditures	NA	NA	NA	NA	NA	NA	NA

NA = not available

e = estimate

a. Data for Industrial Chemicals only, not Chemical and Allied Products.

b. Sales is used as a proxy for value of shipments. It is assumed that sales grew at a rate of about 10%/year from 1972 to 1978.

Source: Robert Morris Associates, Annual Statement Studies, 1972-1978.

TABLE F-97

INCREMENTAL COST OF COMPLIANCE WITH RCRA ISS TO THE CHEMICAL WHOLESALING INDUSTRY

		Cost of Waste Management at the Generator Plant							
		First Year		Annual					
Industry Segment	1978 Value Added ($ Million)	Capital ($ Million)	One-Time Expenses ($ Million)	Closure Fund[a] ($ Million)	Operating ($ Million)	Annual Cost of Off-Site Transportation and Disposal ($ Million)	Total First Year Expenditure ($ Million)	Total Annual Cost[b] ($ Million)	Annual Cost as a Percent of Value Added (%)
Chemical Warehousing (SIC 5161)	1,600.00	0.00	8.32	0.00	0.08	2.35	10.77	5.83	0.36

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a. First of 20 yearly non-tax deductible contributions to closure and post-closure fund.

b. Present value of 20 years of incremental compliance costs inflating at 10%/year for the first 5 years and 7%/year for the years 6-20 multiplied by an annuity factor of 0.1814.

Source: Arthur D. Little, Inc., estimates.

per plant. Since the merchant wholesaling segment of this industry (the only segment expected to be affected by the regulations) is composed of many small plants, there is very little variation in impact among firms. The annual cost of the regulations as a percent of value added is estimated at about 0.4%.

(2) Economic Impact

Table F-98 shows that, with the exception of price increases to cover the cost of RCRA, no significant impacts are expected in this industry.

TABLE F-98

ECONOMIC IMPACT ON THE CHEMICAL WHOLESALING INDUSTRY

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Merchant Wholesaling (SIC 5161) (only segment impacted by regulation)	3400	none	none	none	likely	none	none

Source: Arthur D. Little, Inc., estimates.